AVIATION WEEK

A McGRAW-HILL PUBLICATION

February 3, 1958 75 cents

X-15 Program Probes Manned Space Flight

TV Satellite's Weather Map

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KAYLOCK

All-metal self-locking nuts ®

Kaylock's revolutionary self-locking principle in aircraft nuts won the entire industry's immediate acceptance. Now the United States Patent Office also has recognized the merits of this original principle with the issuance of a patent!

Complete line of Kaylock all-metal self-locking nuts available in steel and A-286 corrosion-resistant steel for use to 1200°F.

Kaylock Nuts conform to all Air Force-Navy standards: AN363, AN364, AN365, AN366, and the new low height lightweight National Aircraft Standards.

Trade Mark

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FROM THE SMALLEST:

THE INFLATOPLANE, shown here in single and two-seater versions, for downed pilots who can "open the valve and fly back," or for tactical liaison. Here is a reliable aircraft which fits into the baggage space of virtually any vehicle.

TO THE LARGEST:

AEW and ASW Airships carrying the largest radar antennas aloft, equipped with the latest scientific detection equipment and armed with homing-type weapons. Holders of world's record for powered flight without refueling, possessing unique all-weather flight capabilities.

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INFLATABLE AIRCRAFT – ONE OF THE PRIME CAPABILITIES OF

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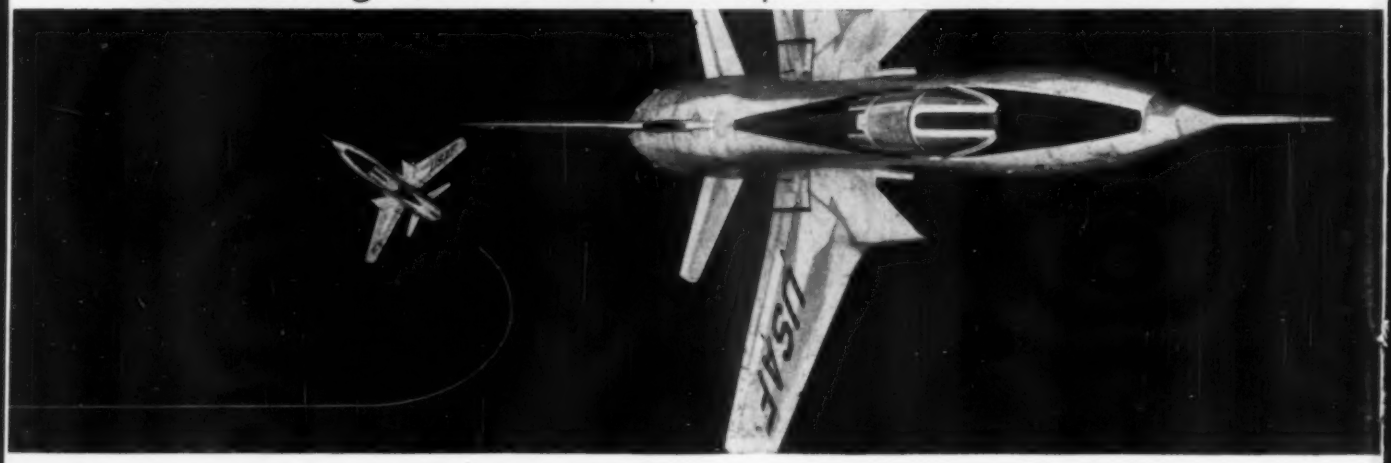
Plants in Akron, Ohio, and Litchfield Park, Arizona. Rewarding Careers for Engineers

Inflatoplane – T. M. Goodyear Aircraft Corporation, Akron 15, Ohio

LMEE flight controls the Republic F-105-Thunderchief



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A DEPARTMENT IN THE DEFENSE ELECTRONICS DIVISION

AVIATION CALENDAR

Feb. 2-7—American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, New York City.

Feb. 3-4—Industry-Service Symposium Flight Control-Panel Integration, Biltmore Hotel, Dayton, Ohio. For details: Mr. J. H. Kearns, Box 942, Dayton.

Feb. 4-6—13th Annual Conference and Exhibit, Reinforced Plastics Div., Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago, Ill.

Feb. 10-14—American Society for Testing Materials Committee Week, Hotel Statler, St. Louis, Mo.

Feb. 17—1958 Conference of Professional Divisions, American Society of Mechanical Engineers. Theme: International Geophysical Year—Technology at the Threshold. Hotel Huntington-Sheraton, Pasadena, Calif.

Feb. 19—"Are Flying Saucers Fact or Fancy?," Dr. Hugh Winn, Missile and Ordnance Systems Department, GE, Engineers Club, Philadelphia, Pa.

Mar. 3-6—Third Annual American Society of Mechanical Engineers Gas Turbine Conference and Exposition, Shoreham Hotel, Washington, D. C.

Mar. 5-6—Second Annual Shock Tube Symposium, Palo Alto, Calif. For details write: Commander, Air Force Special Weapons Center, Kirtland AFB, N. M., Attn.: R. R. Birnkoff, SWRS.

Mar. 13-14—Institute of the Aeronautical Sciences, National Flight Propulsion Meeting (Secret clearance required), Hotel Carter, Cleveland, Ohio.

Mar. 13-14—Fifth Annual Heat Transfer Technical Conference, Oklahoma State University, Stillwater, Okla.

Mar. 13-14—Second National Conference on Aviation Education, Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference,

(Continued on page 6)

AVIATION WEEK • FEBRUARY 3, 1958

Vol. 68, No. 5

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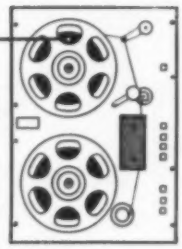
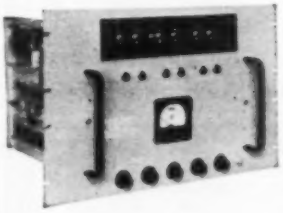
RAPID ACCESS

IN ANALOG DATA REDUCTION SYSTEMS

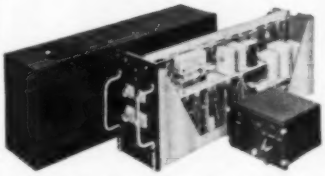


Three companion units by Hycon Eastern provide automatic indexing and high-speed access to selected data in multi-channel magnetic tape instrumentation systems.



For Tape Indexing

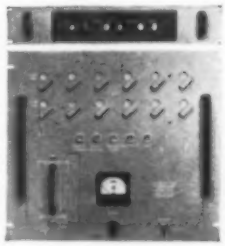
DIGITAL TIMING GENERATOR, MODEL 201, generates numerically coded timing signals which are recorded on magnetic tape throughout the data recording periods, providing a precise digital index in terms of elapsed time. The Generator also visually displays the exact time in hours, minutes and seconds as illuminated digits.

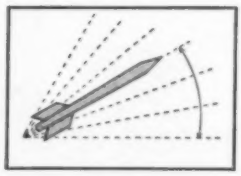


DIGITAL TIMING GENERATOR, MODEL 206A, FOR AIRBORNE APPLICATIONS is a militarized version of Model 201. A Remote Control Box contains Power off-Standby-Operate Switch, the Digital Clock Set, and the Time Display. Completely transistorized, Model 206A includes a binary coded decimal system although other timing formats are available to meet customer requirements. Weighing only 15 pounds, Model 206A is stable to 1 part in 100,000 giving an accuracy of ± 1 second in 1 day's time.

For Tape Search

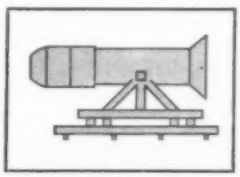
MAGNETIC TAPE SEARCH UNIT, MODEL 202, operates during data reduction periods. On the basis of time indices recorded on the tape by the Digital Timing Generator, this instrument automatically locates and selects for controlled playback the tape data included between a "sequence start time" and a "sequence end time" specified by panel dial settings. The time index is visually displayed as illuminated digits on a small separate panel which may be remotely located for convenience. Model 202 may be modified to search for timing formats other than those originated by Model 201.





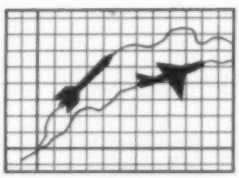
WIND TUNNEL TESTING

Pressure and temperature data of missiles are referenced to angle of attack. Model 201 records on tape a digitized position signal for each new angle of attack.



JET ENGINE TESTING

Digital Timing Generator, Model 201 synchronizes all data receiving equipment. Its output can be piped to multiple test cells and control rooms simultaneously.



MISSILE AND AIRCRAFT TESTING

Model 206A generates timing signals simultaneously with other flight test data. Model 201 generates a timing code format for synchronizing ground station recordings.

Write for Technical Bulletin TSG

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210 E. Manville St., Compton, California

AVIATION CALENDAR

(*Continued from page 5*)

American Rocket Society-American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, 25 W. 45 St., New York City.

Mar. 17-21—14th Annual Conference, National Assn. of Corrosion Engineers, Civic Auditorium, San Francisco, Calif.

Mar. 17-27—International Aeronautical Federation, 51st General Conference, Los Angeles, Calif. For details write: International Aeronautical Federation, 6, rue Galilee, Paris 16e, France.

Mar. 18-19—Conference on extremely high temperatures (over 30,000K), sponsored by USAF Cambridge Research Center, L. G. Hanscom Field, Bedford, Mass.

Mar. 18-19—First Inter-Service and Industry Symposium on Guided Missiles Training Equipment (limited to those with Secret clearance), Naval Ordnance Laboratory, White Oaks, Silver Springs, Md. For details write Mr. J. G. Vaeth, Head of New Weapons & Systems Division, U. S. Naval Training Device Center, Port Washington, N. Y.

Mar. 24-27—Institute of Radio Engineers, National Convention, Waldorf-Astoria Hotel and New York Coliseum, New York City.

Mar. 24-29—Fourth International Instrument Show, Caxton Hall, London.

Mar. 30-Apr. 1—RFC-RNAS Reunion (World War I), Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

Mar. 31-April 4—American Management Assn., Management Methods for Professional People Seminar, Sheraton-Astor Hotel, New York City.

Apr. 8-10—Eighth International Symposia, Electronic Waveguides, Engineering Societies Bldg., 29 W. 39 St., New York City.

Apr. 10-11—Aeronautical Training Society Annual Meeting, Mayflower Hotel, Washington, D. C.

Apr. 10-12—Southwestern Institute of Radio Engineers Conference and Electronic Show, St. Anthony Hotel and Municipal Auditorium, San Antonio, Tex.

Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton-Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York City.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Apr. 28-30—Second Annual Astronautics Conference, sponsored by Air Force Office of Scientific Research and Institute of Aeronautical Sciences, Shirley Savoy Hotel, Denver, Colo.

May 4-7—Fourth National Flight Test Instrumentation Symposium, Park Sheraton Hotel, New York City.

May 12-14—National Conference on Aeronautical Electronics, sponsored by Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio.

May 14-16—Spring Meeting, Society for Experimental Stress Analysis, Hotel Manger, Cleveland, Ohio.

ROTARY ACTUATORS by HOUDAILLE

FOR MISSILE AND AIRFRAME APPLICATIONS
— wherever rotary motion is required

• • • save ***WEIGHT***

• • • save ***SPACE***

• • • save ***DESIGN TIME***

Lightweight rotary actuators by Houdaille will fit envelopes too small for conventional linear types . . . for hinge-line mounting with direct rotary torque output, without mechanical conversion. They eliminate undesirable backlash and provide the most simplified actuating system.

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- **Low internal leakage and high stiffness**
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- **Output directly proportional to input**
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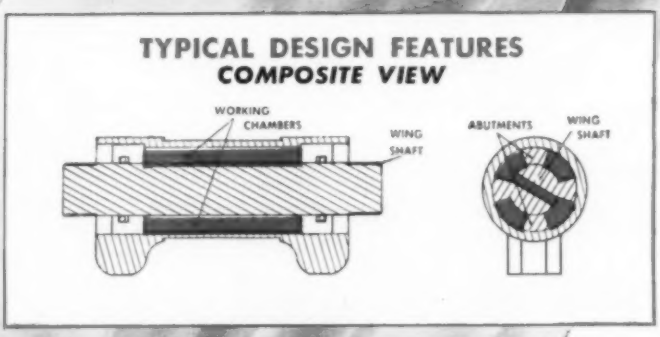

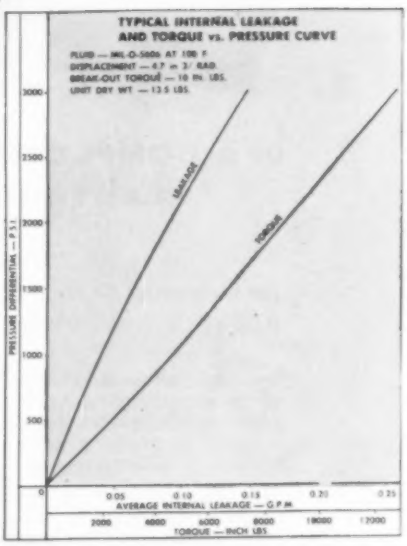

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DIGITAL VOLTMETERS

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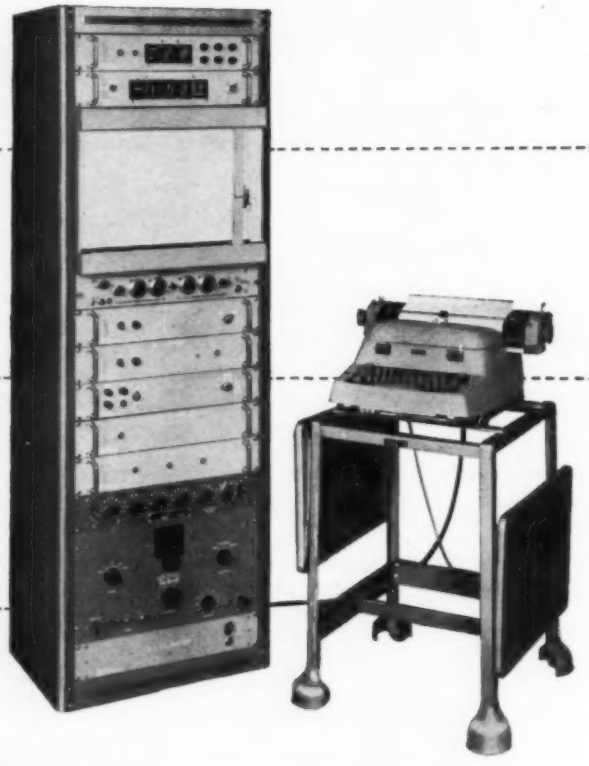

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for measuring DC to 0.01%, AC to 0.1%, Ohms to 0.01%, DC ratios to 0.01% and AC ratios to 0.02%

Standard, off-the-shelf modules never become obsolete—provide maximum versatility. As needs change, simply regroup old modules or add new ones. Your system is always current at minimum cost and engineering. Internal construction is also modularized for ease of maintenance.

Fully transistorized circuits result in increased reliability, reduced power consumption, low heat dissipation, miniaturized packages, and eliminate radio noise and line transients.

Important new specifications—Wider, dynamic ranges cover all voltages from 100 microvolts to 1,000 volts; resistance from 10 milliohms to 10 megohms. Input power frequencies from 50 to 400 cycles. New balance logic speeds down ranging. Automatic AC ranging from 30 to 10,000 cycles. Use of transistors increases switch life by a factor of three.

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This Short Form Catalog gives complete specifications on both basic and auxiliary modules. **Send for it . . . today!**

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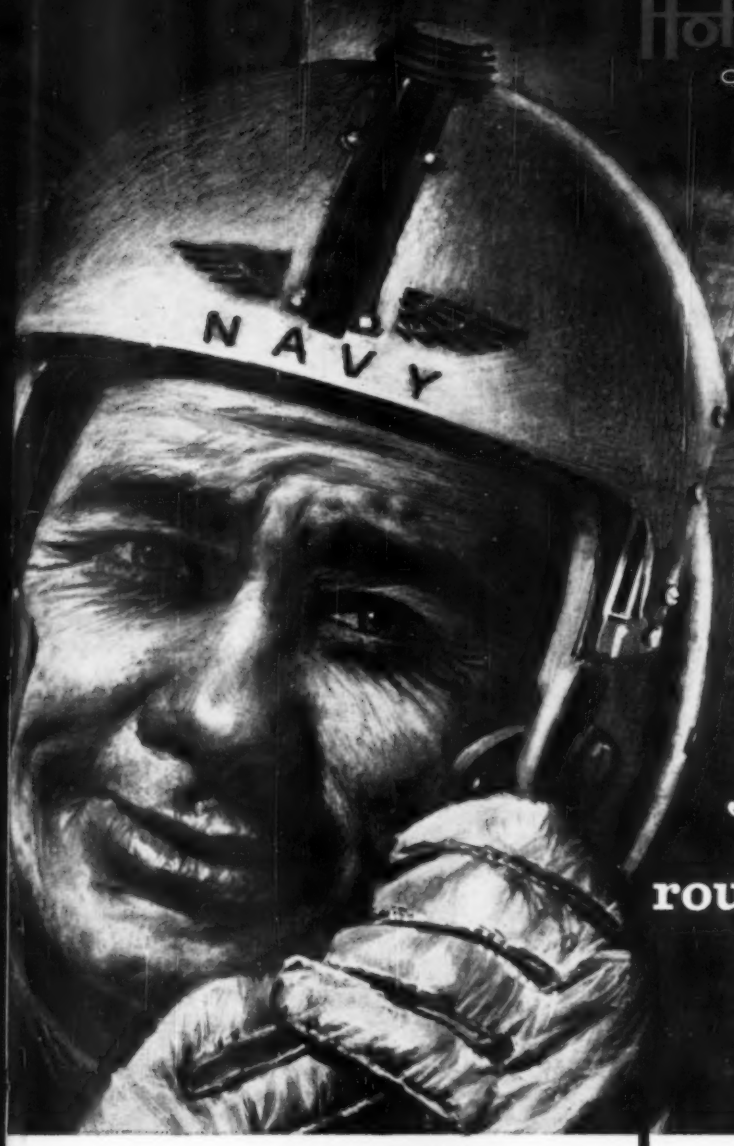

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TACAN-VORTAC distance and azimuth indicators

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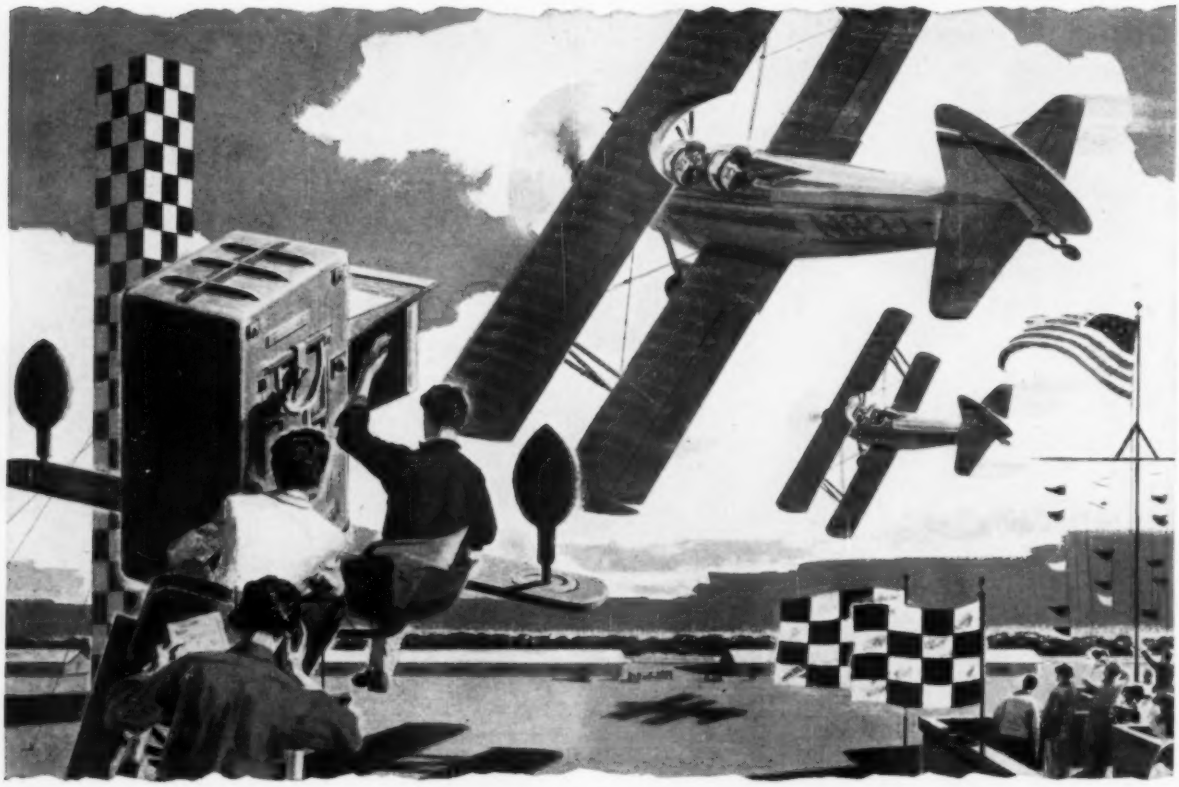
by STANDARD OIL COMPANY OF CALIFORNIA



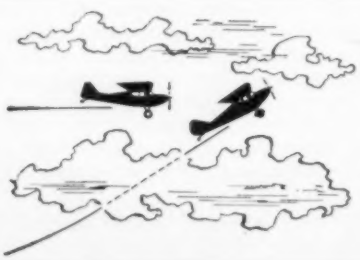
Realism in the movies with daredevil flying

When a movie script calls for pilots and planes to re-enact daredevil flying of the early 1930's, the producers often call on Joe Pfeifer. Hazardous flying of outdated aircraft is bread-and-butter work for him. Operating out of the Santa Susana Airport, in California, he and his fleet of 1930 vintage airplanes have appeared in many motion pictures based on early-time flying adventures.

"Hollywood makes two strong demands when shooting a flight scene," reports Mr. Pfeifer. "One is full power for realism and the other is minimum maintenance problems to eliminate production holdups. I get both with Standard aviation products. Chevron Aviation Gasoline burns clean, never fouls the plugs and gives me the extra power I need for movie stunt flying.

"RPM Aviation Oil keeps the aircraft in top condition and holds engine wear to a minimum. Rings and valves stay clean as new. I've had no engine trouble using RPM . . . and in my kind of flying that's saying a lot."

Mr. Pfeifer's fleet of 27-year old planes, the largest such group of aircraft still flying, includes a restored and modified Pfeifer fleet biplane, Phillips Skylark, Davis DWL and a Fairchild 22.



TIP OF THE MONTH

Avoid flying immediately below or above a cloud formation. Neither is a good place to be should another airplane suddenly pop out of the overcast.

We take better care of your plane

CHEVRON AVIATION GASOLINE

AVIATION OILS RPM

T.M'S "RPM," "CHEVRON," "PLANE FAX," REG. U. S. PAT. OFF.

Target Transponder

PARAMI

Miss Distance Indicator

*Field Tested**

Proven

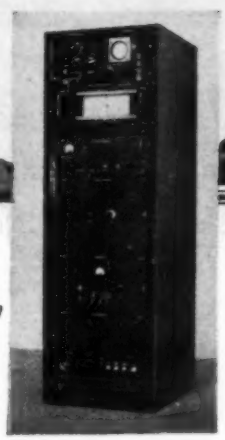
Now in Production

Procurable by Catalog Number

Missile Transponder

PARAMI employs two airborne transponders and a single rack ground station, operates in any weather, at any location, or time. Production equipment for towed targets and drones available on assigned frequencies.

Receiving Antenna
(Tripod Height 4')



Ground Station
(68" High)

This precise electronic MDI features:

1. *A real time printed record in tens of feet.*
2. *195 data points per second (up to 390 available on order).*
3. *Intercept recorded to 100 miles line of sight.*
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5. *Mobile versions for uninstrumented ranges.*
6. *MDI ranges suitable to effective pattern of any warhead.*

	Distance from Target	Accuracy
MISSILE TRANSPONDER	0-200′	±10′
	0-500′	±10′
	0-3000′	±10′
PROXIMITY SCORERS (Adjustable)	0-100′	± 5′
	0-400′	±10′
TARGET LOCATOR ACCESSORY	0-100 mile range	± 2%
	Azimuth	± 5%
	To 70,000′ altitude	± 2%

**Test Results Available on Request*

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Integral stud for cantilever mounting, case-hardened, with tough core for high strength to withstand shock loads.

Easily relubricated at either end or through cross hole in stud. Ends accommodate standard drive grease fittings or plug seals.

Full complement of small diameter rollers for maximum radial capacity and efficient anti-friction performance.

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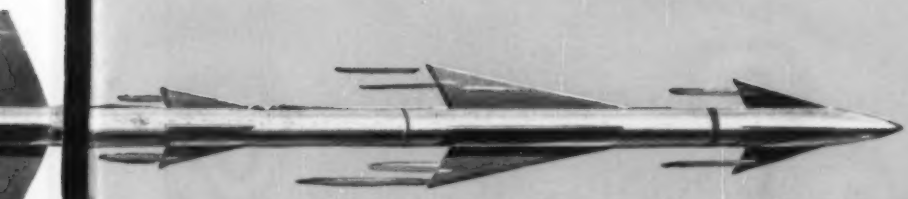

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How X-15 Will Double Man's Mach Number 26

► Inertial navigation system, thick blunt trailing edges are aids in exploration of new flight regime.

Capitol Puts 880 Near Breakeven Point 40

► Convair's financial guarantee in turn offers airline an answer to pressing fiscal, equipment problems.

Weightlessness Crucial Spaceman Factor 50

► Definition of space crew roles must wait until effects of prolonged weightlessness are better known.

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EDITORIAL

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COVER: Weather map of North America as it would be transmitted by television from a satellite 4,000 mi. over Amarillo, Tex., was drawn by Dr. Harry Wexler, director of meteorological research, U. S. Weather Bureau. Surface features are drawn taking into account earth's normal colors, reflectivity of sunlight, scattering and depleting effects of light passing through the atmosphere, with calculated brightness of various cloud types. Weather features are a family of three cyclonic storms extending southwest from Hudson Bay to Texas; similar system over the bay of Alaska; small hurricane developing in normal trade wind cloud pattern just north of Puerto Rico; equatorial front—meeting zone of northeast and southeast trade winds—extending west of the Isthmus of Panama to mid-Pacific; line squall in the Eastern U. S.; scattered cumulus clouds over heated land areas; lenticular clouds usually found where the jet stream crosses mountains as over the northern Canadian rockies, and low stratus and fog off California coast, over the Great Lakes and in the Newfoundland area.

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EDITORIAL

NACA, The Logical Space Agency

Too often in recent history, the solution to acute national problems has been sought in the creation of complex new organizations that add to the federal payroll and bureaucracy but do little about the problems they were created to solve. Often, an economical and effective solution lies close at hand, but is so simple the top-level officials hesitate to even consider it. The current debate over how many and what kinds of organizations the federal government needs to organize and guide research and exploration of space appears to be a case in point.

There is no lack of complex plans to tackle our space age problems. In the midst of this furor it is finally becoming clear that there is in existence an extremely competent organization capable of spearheading this work—the National Advisory Committee for Aeronautics established by the President in 1915 with the directive to "supervise and direct the scientific study of the problems of flight with a view toward their practical solution."

Credit for first calling attention to this simple but effective solution, we believe, belongs to Gen. Orval Cook, president of the Aircraft Industries Assn., who told the Institute of Aeronautical Sciences in Washington on Jan. 14:

"One of the things that has most puzzled me during this furor and clamor for government reorganization so that we can catch up with the Russians has been the fact that NACA has apparently been largely overlooked. Yet here is a government agency reporting directly to the President which has as its basic charter 'the scientific study of the problems of flight with a view toward their practical solution.'

"For more than 40 years NACA has dedicated itself to this task with outstanding success. The NACA has some of the finest aeronautical laboratories in the world—its facilities alone being worth more than $300 million, and an operating staff of some 7,600 people of whom more than 2,000 have professional degrees.

"For more than 10 years it has been conducting research and studies in scientific fields leading to man's conquest of space. In fact early in 1952, months before the first manned flight at Mach 2, NACA studies were launched into the problem of manned flight beyond the atmosphere and their solution. By 1954, NACA research teams were able to propose construction of a research vehicle for this purpose and in December, 1955, in cooperation with the Navy and Air Force, a contract for this craft (North American X-15) was let. This vehicle is expected to be test flown within the next 12 months or so.

"NACA also pioneered in research that will pay off in manned boost-glide rockets flying at fantastic speeds and with a new concept that will enable our ballistic missiles to withstand sun-hot temperatures during re-entry into the atmosphere.

"At the same time these projects were under way, the NACA has been investigating almost every element in the propulsion spectrum. Research is being conducted in propulsion by ion jets, photon jets, plasma jets, by nuclear rockets and by solar power. Much more than mere theory is involved—practical experimentation is being conducted and detailed performance parameters are being developed. All of this research is directed toward one goal—flight, manned and unmanned, at incredible speeds through and beyond the Earth's atmosphere. All of this vital basic research information is being funneled to the military services and the aviation industry to assist them in development of vehicles to translate this research into reality.

"If, as so many people are advocating, we need a governmental agency to take the responsibility for accelerating our efforts in space travel, I suggest we look to an existing organization such as the NACA to provide this direction."

We heartily endorse Gen. Cook's suggestion and strongly urge members of Congress concerned with this problem, Defense Secretary McElroy and the public—which will eventually have to pay the bills—to carefully consider this relatively simple but effective solution of a most acute national problem.

There are several additional considerations, in addition to those cited by Gen. Cook, that make the NACA role as the spearhead of our national space research and development effort extremely attractive.

First, it has, through 40 years of experience, established an extremely effective working relationship with all of the other basic organizations concerned with this problem—the military services, the scientific fraternity and the industrial complexes. Through its main and subcommittee structure, it provides adequate voice for all of these elements in determining a national policy.

Second, the caliber of its leadership evokes universal respect from the other agencies through which it works. There is no better man in the nation today than James Harold Doolittle, NACA chairman, to serve as a link between the military, scientific and industrial communities because he has had outstandingly successful careers in all three areas. The scientific leadership of Dr. Hugh L. Dryden, director of NACA, is based on a combination of solid scientific achievement and quiet but effective administrative ability, all too rare in scientific circles.

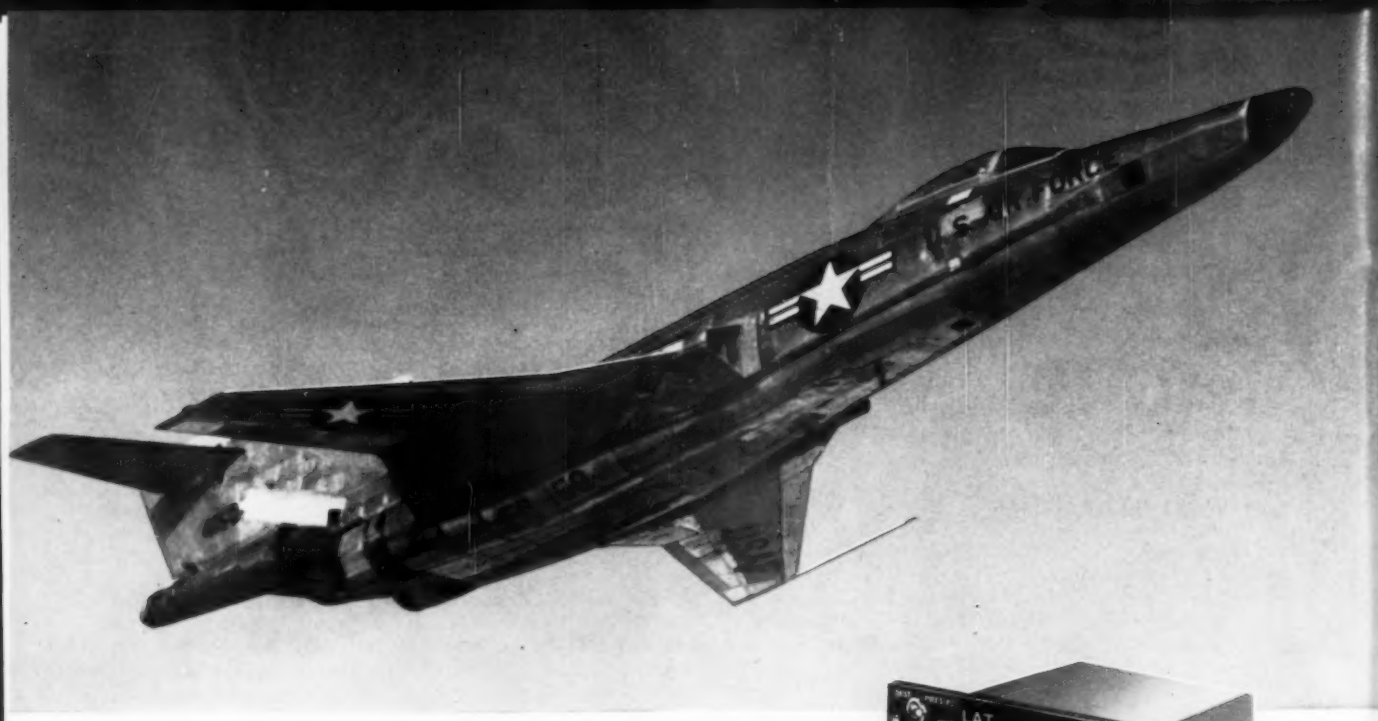
Third, NACA has proven its ability in the past to contribute significantly to urgent national technical problems. It developed the laminar flow wing in time to permit the P-51 Mustang to escort heavy bombers to any German target at the critical phase of World War II. Its high speed research aircraft program was an outstanding post-war example of joint work with the military and industry to produce maximum progress in minimum time and launch our military aircraft into the supersonic age a significant jump ahead of all competitors. Its work in ballistic missiles has also solved key bottlenecks in time to be useful in operational weapons.

Fourth, NACA has shown extraordinary ingenuity in devising new research tools required for tackling the unknown. The transonic wind tunnel, rocket powered models, gas dynamics facilities and multi-stage research rockets are a few examples of this ability which is absolutely essential in probing new frontiers fruitfully.

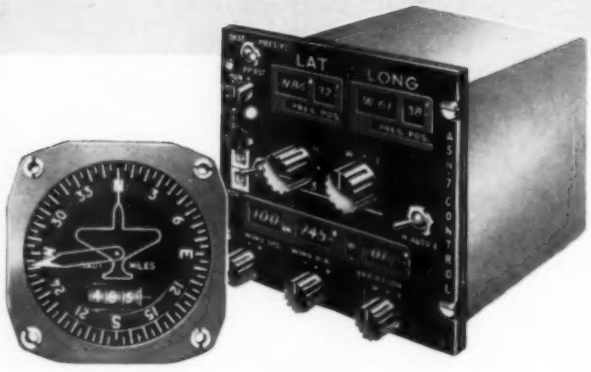
It is a major technical fallacy to consider aeronautics as a field that extends to the limits of the Earth's atmosphere and astronautics as something that begins where the atmosphere ends. Both are integral parts of the same overall scientific problem. Any successful efforts in making the useful plunge into outer space must be based on the foundation of knowledge already accumulated on flight through the atmosphere from sea level to its outer fringes. Any space vehicle must also successfully pass through the envelope of atmosphere both on its outward and return journeys.

There is a strong case to be made for charging NACA with the job of spearheading our national advance into space with a minimum of time and new money required to achieve the strong possibility of maximum progress. If NACA gets the job, our jump into space will be catapulted from a solid launching pad.

—Robert Hotz



▲ Among new, fast military aircraft being equipped with the ASN-7 Automatic Navigation Computer, are the McDonnell Voodoo RF-101 photo-reconnaissance plane, shown above, and the F-101B all-weather interceptor. Prior to setting a new world's closed-course speed record of over 1200 mph, the Voodoo had set new transcontinental speed records. Speed and range of the Voodoo give full scope to the ASN-7's usefulness. Flight-indicator dial and control panel (right) give pilots an indication of where they are, their ground track, and the course and distance to their destination and to alternate destinations.



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WHO'S WHERE

In the Front Office

The following officers of the new company, Astrodyne, Inc. (under joint ownership of North American Aviation, Inc., and Phillips Petroleum Co.) have been announced: **J. L. Atwood**, president; **R. W. Thomas**, vice president; **R. A. Lambeth**, treasurer; **Paul J. Parker**, secretary. Mr. Atwood is president of North American, and Mr. Thomas is Phillips' vice president for research and development. Eight officials of the two companies were elected directors; from North American: Messrs. Atwood, Lambeth, J. S. Smithson and S. K. Hoffman; from Phillips: Paul Endacott, Stanley Learned, W. W. Keeler and Mr. Thomas.

Donald H. Putnam, president, G. M. Giannini & Co., Inc., Pasadena, Calif.

Dr. Franklin E. Lowance, vice president-engineering, Crosley Division, Avco Manufacturing Corp., Cincinnati, Ohio. Dr. Lowance succeeds **Clarence G. Felix**, now vice president-marketing.

Dr. Theodore K. Steele, vice president-research and engineering, Bulova Research and Development Laboratories, Inc., Woodside, N. Y.

Irwin A. Binder, vice president-manufacturing. The Ramo-Wooldridge Corp., Los Angeles, Calif.

Richard N. Golbach, vice president-marketing. Semiconductor Division, Hoffman Electronics Corp., Evanston, Ill.

Grove Webster, vice president and general manager, Purdue Aeronautics Corp., Lafayette, Ind.

Dr. Richard H. Jordan, Assistant Technical Director in charge of Operations Analysis, Airways Modernization Board, Washington, D. C.

Honors and Elections

Dr. Kurt H. Hohenemser, chief aeromechanical engineer, Helicopter Division, McDonnell Aircraft Corp., was selected as the first recipient of the annual Grover E. Bell Award for outstanding work in the field of helicopter development.

Changes

Dr. Albert C. Hall, director of research, The Martin Co., Baltimore, Md. Dr. Hall's headquarters will be at the Denver Division; he will direct the technical activities on the Titan project.

Neil E. Firestone, general manager, Production Engine Department, Aircraft Gas Turbine Division, General Electric Co., Cincinnati, Ohio.

Hilliard W. Paige, manager-nose cone section, Missile and Ordnance Systems Department, General Electric Co., Philadelphia, Pa.

F. A. Ford, Jr., supervisor-preliminary design, and **W. K. Brehm**, supervisor-operations analysis, Convair-Astronautics, division of General Dynamics Corp., San Diego, Calif. Also: **Dr. C. M. Whitlock**, assistant to the chief physician for Astronautics, in the field of space medicine research.

(*Continued on p. 107*)

INDUSTRY OBSERVER

► Recent rapid progress in solid propellants development probably means limited production orders for the liquid-propellant Thor and Jupiter intermediate range ballistic missiles. Navy recently gave Air Force an extensive presentation of progress with its solid-propellant Polaris IRBM. Under present Department of Defense planning, both the Thor and Jupiter will be produced for Air Force on a single-shift basis.

► Navy believes recent breakthrough in Polaris fleet ballistic missile program will bring the 1,500-mile missile into the inventory even before its new 1960 target date. Original target date was 1963. If Polaris is ready before the new target date, initial quantities probably will go aboard surface ships since the first of its submarines isn't scheduled for completion until 1960. In the push to accelerate Polaris, Aerojet-General's Solid Rocket Plant, which is developing the solid propellant propulsion system, has expanded from a nucleus of five in 1956 to a present working force of over 700.

► Air Force estimates average direct cost of an Atlas-type intercontinental ballistic base in the continental U.S. will be approximately $290 million. Total excludes costs of missile warheads, land acquisition and training. With the same items excluded, USAF says direct cost of the first operational intermediate range ballistic missile squadron should run approximately $41 million.

► Douglas Genie MB-1 air-to-air rocket with a nuclear warhead was being delivered to operational units of the Air Defense Command several months before its first firing as an integral unit at AEC's Nevada test site last July. First Genies were placed into Defense Command's weapons inventory in January, 1957.

► Bell Rascal air-to-ground missile is scheduled to become fully operational with the Strategic Air Command in April.

► Fiat G. 91T two-seater transonic trainer developed from the NATO light tactical strike fighter, probably will get approval for production from the Italian government. Negotiations are under way to build an initial quantity of 20 aircraft.

► First West Coast SAGE facility, including both direction and combat centers, is scheduled for completion before June 1. Facility is located at McChord AFB, Wash.

► Sikorsky Division of United Aircraft, which has remained outside the light helicopter business field during the last few years, may get back in again with its S-51. The division may take back a minimum of 30 from their present owners, modernize them and offer them for resale. Changes being contemplated include an improved rotor system or a Westland Widgeon type cabin.

► Thirty-two Avro CF-105 Arrow interceptors will be built under present Royal Canadian Air Force plans. The Canadian program, similar to USAF's Cook-Craigie plan, calls for a large initial order of aircraft to accelerate the test program. Aircraft will be built on production tooling so that needed changes can be made quickly and operational aircraft produced in a minimum amount of time.

► Air-sea rescue version of Piaggio 155 flying boat has been ordered as a prototype by the Italian government. The twin-engine aircraft features a high length beam ratio, will be powered by Pratt & Whitney R2800 piston engines.

► Army is seeking to determine kill potential of its Nike Zeus anti-missile missile through scale model tests at Bell Telephone Laboratories, Whippany, N. J. Spokesmen say that in tests thus far "we have gotten average miss distances well within the accuracies required." Work on full-scale mockups of the Zeus is under way at Douglas Aircraft's Santa Monica, Calif., plant.

Ski-Jump with Jet Assist

A new version of the Fairchild C-123 is now flying with the USAF. Its wheel-ski combination gear enables it to operate from ice or snow-covered fields as effectively as from unprepared dirt strips.

Takeoff performance shoots up with the addition of a Fairchild J44 jet engine at each wing tip. Substantial increases in payload have become possible—takeoff and landing weights over 60,000 lbs. have been achieved and will become routine.

The ski-and-jet C-123 is typical of the versatile development and the potential Fairchild builds into its aircraft.

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Washington Roundup

IRBM for Army?

Watch for Army to move quietly back into the intermediate range ballistic missile field. Former Defense Secretary Charles E. Wilson's order putting a 200-mile-range limit on Army missiles already has been relaxed to make way for the Pershing, a solid-propellant version of the Redstone, which probably will have a range of approximately 500 mi. The new order, signed by Wilson's successor, Neil McElroy, gives the Army leeway to further extend the range through advances in the state of the art so long as the service feels the range falls within its tactical requirements. Army Secretary Wilber Brucker considers 1,500 mi. well within tactical requirements.

Bilateral Limbo

Negotiations between the State Department and foreign governments on civil air transport agreements are in limbo. Pending are talks with France, Belgium and the Scandinavian countries with no specific date set for resumption. Although Russia and the U.S. have agreed "in principle" to an exchange of routes, no date has been set for a conference to work out detailed terms and conditions.

Yet to come are talks with Japan and the Philippines, probably late in the spring or early summer.

Final Conclusions

Findings and conclusions of the Senate Preparedness Subcommittee released by Sen. Lyndon Johnson (D.-Texas) are not the first thorough appraisal of U.S. defenses and technological advances as compared with Russia.

Almost one year ago, a special Air Force Subcommittee headed by Stuart Symington (D.-Mo.) released a report that contained a similar listing of deficiencies with an appeal that they be "corrected as promptly as possible."

Fourteen of the 17 recommendations as well as five of the six findings, made by the Johnson Subcommittee were mentioned in Symington's Airpower Report. The Johnson Subcommittee recommendations not covered in the Airpower Report were the exchange of scientific and technical information, the question of stockpiles and shelters for civil defense and more effort in the development of manned missiles.

The only additional finding in the Preparedness report was that the Soviet Union had led the world into outer space, a fact that was not a reality at the time of Symington's report.

Although the two reports were similar, reaction to the two was not.

Following the Symington report last year, these developments took place:

- **Production schedules** of the Boeing B-52 were cut back from 20 to 15 aircraft per month.
- **Production schedules** of the Boeing KC-135 jet tanker were cut from 20 to 15 per month.
- **Defense Department directive** cut $170 million from support of research and development.
- **Ceiling was placed** on defense expenditures for Fiscal 1958.
- **Funds for the development** of an atomic aircraft were cut.

Following the appearance of the Soviet Union's Sputniks and the beginning of the Johnson Subcommittee investigation, these events took place:

- **President Eisenhower** showed a personal interest in reorganizing the Defense Department and a committee was appointed by Defense Secretary Neil McElroy to recommend changes.
- **Production of Thor and Jupiter** intermediate range ballistic missiles was authorized and development of Atlas intercontinental ballistic missiles and Polaris fleet ballistic missiles was accelerated.
- **Basic research projects** were restored to former levels.
- **Overtime restrictions** were removed from ballistic programs and some of the other Defense Department high-priority programs.
- **Satellite programs** were accelerated.
- **Early warning systems** and anti-missile missile programs were accelerated.

Defense Reorganization

Administration's proposals for reorganization of the Defense Department will not reach Congress before the end of March, by Secretary Neil McElroy's estimate. Streamlining is expected to give McElroy more direct authority over specific military programs as well as greater control over funds.

Group named by McElroy to help him with the reorganizing chore is supposed to gather the views of service secretaries and chiefs of staff and others, and report to him individually. McElroy will then relay the conclusions to the President. Advisors are William C. Foster, member of the Gaither committee (AW Dec. 2, p. 28) and former Deputy Defense Secretary; Nelson A. Rockefeller, chairman of the President's Advisory Committee on Government Reorganization and contributor to the Rockefeller report (AW Jan. 13, p. 34); Army Gen. Omar N. Bradley and Adm. Arthur W. Radford, retired chairmen of the Joint Chiefs of Staff; USAF Gen. Nathan F. Twining, present JCS chairman; and Charles A. Coolidge, former Assistant Defense Secretary and author of the Coolidge report on classification of defense information, as full-time special assistant.

Budget Scientists

Main target of scientific leaders testifying on Capitol Hill on the need for an expanded scientific and technological program is the Bureau of the Budget. Department of Defense is running a close second. Dr. L. V. Berkner, president of Associated universities, protested that since the end of World War II, the Budget Bureau has repeatedly made "very disastrous cuts" in vital basic science projects. For example, he said, funds for the rocket research program of the Naval Research Laboratory were cut off twice. Instead of the present practice of "arbitrary cuts" by budget and accounting officers, he said scientific projects should be periodically reviewed and weighed by scientific groups.

If this were done Berkner estimated that "millions of dollars could be saved."

Scientists' main criticism of Defense Department is its record of de-emphasis of basic research and an overemphasis of engineering development.

Berkner estimated that Defense Department's total basic research effort now amounts to only about $30 million a year. —Washington staff

How X-15 Will Double Man's Mach Number

Inertial navigation system, thick blunt trailing edges are aids to exploration of new flight regime.

Washington—X-15 rocket research aircraft, forerunner of manned orbital bombers, is a 50-ft.-long cylindrical flying fuel tank with small, missile-like control surfaces, an inertial navigation system and a potential for altitude exploration that may range as high as 200-300 mi.

Featuring an unusual number of automatic aids to assist the pilot beyond the limits of human factors the X-15 still requires manned control. It will determine the future of manned aircraft while it explores heating and re-entry problems.

Longer Range

X-15's range is some four and a half times that of the X-1 and X-2—450 nautical miles versus 100. Duration of powered flight is closer to that of the earlier research rocket craft—about six minutes.

Unusual feature of the vertical control surfaces is the extremely blunt trailing edge, measuring 12 in. across. Vertical surfaces are a ventral fin that is jettisoned on landing, and an upper vertical fin whose top portion rotates as the control surfaces do in the Bomarc interceptor missile.

Modification of the X-15, with booster added, probably constitutes North American Aviation's entry in Air Research and Development Command's Rocket Orbital Bomber, (Robo) competition, which closed last August.

Robo specifications were very general but extremely high speed, far beyond X-15's Mach 5-7 range, was called for. Speeds may have been two to three times that of the X-15.

Both manned and unmanned versions and ballistic and glide rocket bombers were proposed in the Robo competition. Unmanned version, probably for reconnaissance work, would include radar, infrared or optical scanning devices, with provision for relaying their intelligence to ground stations.

Competitors included at least five companies—North American Aviation, Inc.; Boeing Airplane Co., and Bell Aircraft Corp., whose studies were supported by USAF; and Douglas Aircraft Co., Inc. and Republic Aviation Corp.

Maximum gross weight of the X-15 is some 32,000-33,000 lb. Structure is primarily steel. Three copies will be built. Thrust of the single barrel engine is about 60,000 lb. at maximum output.

X-15's fuselage is integral tankage forming a constant-section body of revolution for about 27 of its 50 ft. length. Diameter is 4 ft. at tail. Two oblong tanks for fuel and oxidizer contain baffles shaped like radar dishes, facing forward, to control surge and center of gravity. Tube 12-in. in diameter runs the full length of both tanks, probably serving as a structural member as well as a fuel line.

Propellants probably will be anhydrous ammonia and liquid oxygen. Kerosene will not be used.

Third tank, for gas generator fuel, is spherical in shape and located aft of oblong tanks.

Two very large bulges of generally triangular shape begin on the side of the X-15 fuselage just behind the canopy. Each terminates at the aft end of the fuselage in a large blunt triangular base. The wings extend from the fuselage through these bulges. The primary purpose of this somewhat unusual configuration is to minimize interference drag between the fuselage and the wing, which can become predominate at X-15 speeds without careful design.

These bulges also contain all lines, controls, wires, plumbing, control surface actuators, etc., and are made of beryllium to resist heat.

Wing leading edges are sharp but not as sharp as those of the F-104. Trailing edges are blunt, tapering from 2¼ in. thick at root to ¾-in. at tip. All corners on control surfaces are slightly rounded.

Wings have small, deep chord supersonic ailerons located approximately in mid-wing.

Horizontal Stabilizers

Horizontal stabilizers, approximately 4 ft. long, have 15 degree anhedral.

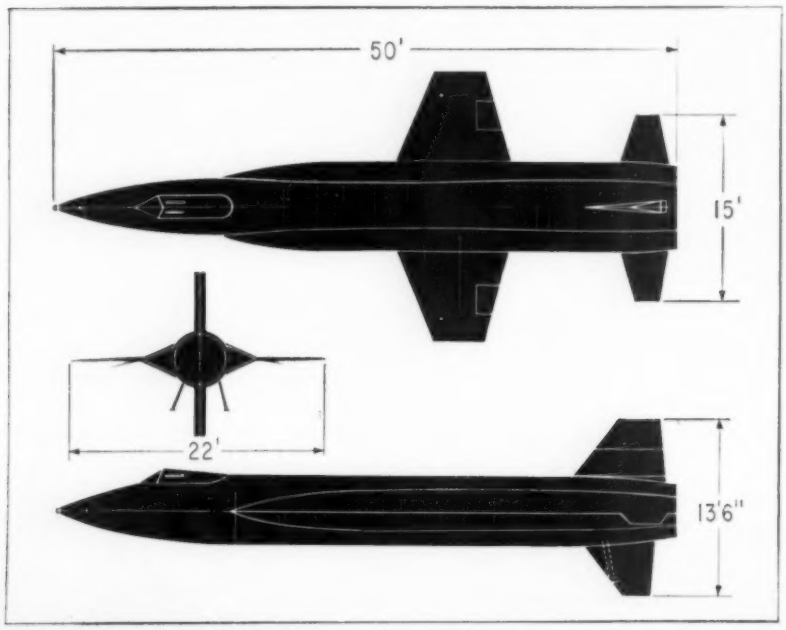
Upper vertical control surface is approximately 5 ft. high. Whole upper half rotates for aerodynamic yaw control.

The leading edge is swept back 40 deg. from the vertical and trailing edge has 5 deg. forward sweep. Ventral fin, about 4 ft. long, jettisons on landing. Both have trailing edges 1 ft. across.

Jet reaction ports 1½ in. in diameter for roll control at extreme altitudes are located 80% forward on wing and 2 ft. inboard and are directed upward.

Pitch and yaw control rockets are located in the nose at top and bottom of fuselage. Capt. Iven C. Kincheloe, scheduled to be the first USAF pilot to fly the X-15, said it has not been decided yet whether the rockets are capable of fine enough control independently, or whether it will be necessary to balance them against one another to get fine control from the difference in thrust.

Joseph A. Walker, first National Advisory Committee for Aeronautics pilot scheduled to fly the aircraft, said the pilot will throttle the control rocket



ARTIST'S conception of X-15. Note rear view at left center.

ARTIST'S conception of rocket-powered North American X-15 shows stubby wings, tiny windows for side visibility.

quite directly without the interposition of many black boxes between him and the jets.

Bell X-1B is now flying with reaction controls to gain more data on control techniques.

X-1B does not have enough room for yaw and pitch rockets in the nose, and they are located elsewhere.

Attitude control rockets in the X-15 are fueled by high test peroxide, a monopropellant generating thrust by its decomposition when set off by a chemical catalyst.

Because high altitudes destroy the usefulness of pilot-static instruments such as altimeter and air speed, and because extreme speed limits the usefulness of other instruments, the primary navigational system is inertial, telling the pilot his position in all three dimensions.

NACA-developed nose instrumentation is contained in a 6-in. diameter hemisphere and fulfills usual functions of a nose boom. An alternate nose has the standard boom. Nose of the cockpit is made of glass but side visibility is limited to two small windows.

Landing gear is two skids which pop out of blisters on the sides of the aft part of the fuselage.

This type was chosen to save weight, and because of the availability of the dry lake at Edwards Air Force Base for landing.

X-15 will be lifted to 30,000 or 40,000 ft. by a modified B-52 bomber.

In early flights at least, X-15 probably will start at Wendover AFB near Salt Lake City, Utah, and end at Edwards. Very complete tracking and telemetering equipment is being installed along the route.

Salt flats near Wendover and along the route also provide emergency landing sites.

NACA is flying the X-1 and X-1B on a weekly schedule to check the approaches to be used by the X-15.

Re-entry is expected to be the biggest problem in the aircraft's flights. Trick will be to come into the atmosphere at

X-15 History

X-15 is scheduled to fly early in 1959, seven years from the time that National Advisory Committee for Aeronautics began special studies of problems likely to be found in flight beyond the atmosphere, and the means for exploring them.

On July 9, 1954, NACA met with USAF and Navy Bureau of Aeronautics to propose the X-15 as an extension of the cooperative research aircraft program. In December of that year a memorandum of understanding was signed naming NACA technical director of the project, with advice from a joint Research Airplane Committee.

USAF was assigned to administer design and construction. It also provides the bulk of the money for these and support phases. Navy assists in financing and provides test facilities, particularly the human centrifuge at the Air Materiel Center, Johnsonville, Pa.

Competition began in December, 1954, and in December of 1955, North American Aviation, Inc., was ordered to construct three aircraft. Reaction Motors, Inc., is powerplant contractor.

North American pilot Scott Crossfield, first man to fly at Mach 2 when he was still with NACA, is scheduled to make contractor flight tests to determine structural integrity and satisfactory performance of propulsion and control systems. Crossfield will go only to an altitude of about 60,000 ft.

Capt. Iven C. Kincheloe, Jr. of Air Force Flight Center, Edwards AFB, Calif., is first USAF pilot. He will determine maximum speed and altitude capabilities. Joseph A. Walker will be first NACA pilot. They will have two back-up pilots each.

NACA will have primary responsibility during all research flights. It will operate the range from Wendover AFB, Utah, to Edwards, and be responsible for data reduction and reporting.

Flight Test Coordinating Committee composed of USAF and NACA representatives and a Navy liaison officer will monitor the program. NACA will make results of flights and tests known through its usual channels and also through conferences with industry.

the proper angle, which will be very shallow.

A flight test possibility is a full scale trial of the skip maneuver, coming into dense air for a very short time, then pointing the nose up and coasting back into very thin air again. Two schools of thought have grown up surrounding this type of flight path.

Heat Problems

The NACA at Ames Laboratory feels that the skip will result in higher structural temperatures during re-entry. Radiative equilibrium temperature, NACA says, is the minimum that can be achieved in the upper air. If the aircraft skips continuously back into space it cannot be cooled by radiation of structural heat back to the atmosphere, and its equilibrium temperature will be higher than an aircraft which followed a glide path after re-entry.

Other experts, such as Antonio Ferri, believe that efficient structure can distribute the heat evenly while the aircraft skips back into space and that the intermittent heating during skipping will result in a lower body temperature than radiation equilibrium temperature.

Estimates of well-informed observers are that the 100 mi. altitude usually discussed is too conservative. Peak altitude may be in the 200 to 300 mi. range.

Heavy emphasis will be put on human factors and instrumentation research in the X-15 program. USAF Maj. David G. Simons has been designated human factors coordinating officer.

Pilot's authority over fuel control will be limited to prevent him from exceeding the human tolerance to acceleration, according to Walker.

In re-entry, determination of effects of heat rise on controls and on the pilot's responses will be an important goal. Temperatures expected to be encountered are far greater than any experienced so far, perhaps as high as 1,000F. But short exposure time probably will mean little discomfort inside the cockpit.

Subjection to long periods of zero gravity are not expected to affect pilots adversely. Although Brig. Gen. Homer A. Boushey, USAF deputy director for research and development, says approximately five minutes of weightless flight can be achieved in the X-15, Capt. Kincheloe feels that a pilot can take up to one hour at zero G very well. Kincheloe was at 0.05 G for 50 sec. in the X-2 and didn't know it until instrument readings were taken after he landed.

Longest flight time in the X-2 was 17 min., 14 sec., by Kincheloe. X-15 times will be considerably longer. Pilot will breathe bottled oxygen, which is not considered efficient enough for an orbital vehicle. If X-15 were made orbital, finding room for a more efficient air regeneration system would be difficult.

NAA's Net Income Declines $3 Million

Los Angeles, Calif.—North American Aviation Inc., last week reported its net income for the first quarter of the firm's 1958 fiscal year dropped $3,436,000 under a similar period last year.

Board Chairman J. H. Kindelberger said net income was $6,462,000 after provision for $7 million for federal income taxes in the three months ended Dec. 31, 1957. Net profit was $.81 per share on 8,015,077 shares outstanding, compared with $1.23 per share on the same number of shares in a like quarter of the previous fiscal year, according to unaudited figures.

Net income in that quarter, part of North American's biggest year, was $9,898,000 after provision for federal income taxes of $10,722,000.

"The decline in sales," Kindelberger said, "is a result of the substantial reductions made in late 1957 by the government in military expenditures which included contract terminations, cutbacks and schedule stretchouts.

"Despite this present trend, we are optimistic over the company's long range prospects as one of the principal suppliers of weapon systems, related military equipment and diversified products."

Sales and income for the first three months ended Dec. 31, 1957, amounted to $222,849,155, a drop of $7,677,785 under the like quarter a year ago. Costs of sales and other expenditures totaled $209,387,155, compared with $309,906,940 in the prior year.

As of Dec. 31, North American had a backlog of unfilled orders worth $611,447,504. This compares with $581,000,000 in unfilled orders as of Oct. 1, 1957, start of the fiscal year. Company says backlog figure does not include portions of new orders not yet finally committed. In late December, North American won a USAF competition to develop manned weapon system WS-110A for Strategic Air Command.

Bell, Vertol Merger?

Top managements of Bell Helicopter Corp. and Vertol Aircraft Corp. are reportedly discussing a merger of the two firms, with Vertol apparently becoming a division of Bell if an agreement is reached. Final decision is expected within the next few days.

Bell is said to be interested in Vertol's experience in large, relatively long-range helicopters—a field in which Bell has been interested in for some time. Most of Bell's sales in the past few years, however, has been in the light helicopter field.

Space Is Booming, Meeting Crowds Show

New York—Bulging attendance at the American Astronautical Society's annual meeting here last week and at sessions on advanced subjects such as gravity at the Institute of the Aeronautical Sciences meeting clearly indicated how space has captured technical as well as general interest in the U.S.

• **Gravity** sessions held in a ballroom seating 1,000 persons were besieged by 1,500 people who wanted to get in.

• **Astronautical** Society meeting attendance was six to seven times greater than any previous meeting.

Mushrooming interest on the part of engineers that gravity research might bring an answer to propulsion problems had to be discouraged by speakers.

Louis Witten, principal scientist for Martin Co.'s RIAS, Inc., stressed that, "There is today no indication in gravitational theory how such use can ever be made of gravitation." Furthermore, he said, there are clear indications from our present understanding of gravitation that such use cannot be made.

Witten urged, however, that physicists consider gravitational theory as able to contribute to the main present-day problem of physics: the problem of fundamental particles. Physicists have tended to ignore gravitation, he said, because of the weakness of gravitational force compared to other forces. For example: for two electrons which attract each other because of gravitation by an inverse square law and repel each other because of their charge also by the inverse square law, at all distances the electrostatic force of repulsion is greater than the gravitational force of attraction by the enormous factor of 10^{40}.

The absolute size of a force is not necessarily a good clue as to its qualitative significance, he argued. Also, the theory of gravitation is a theory of space and time itself and one must have a proper theory of space and time in order to understand the behavior of objects within space and through time.

Rate of applications for membership in the Astronautical Society has increased by a factor of almost five since the first Russian Earth satellite was launched. In the first eight hours of the meeting, the Astronautical Society got 116 new membership applications.

The Russian activity and rapid influx of new members has changed the Society's problems overnight. Until last Oct. 4, AAS was struggling with the organizational difficulties of any new society seeking professional standing and a large membership. The long process of earning professional status was culminated at the annual meeting when the AAS was officially made an affiliate of the American Association for the Advancement of Science. This organization sets the standards for most U. S. scientific professional societies.

The large increase in membership, which is estimated to top 1,000 before the end of 1958, has eliminated the most difficult part of the recruiting program and suddenly presented AAS leaders with the problems of a more mature professional society. These problems constantly center around increasing the technical quality of the society's papers and activities and improving communication between members. Ross Fleisig, new president of the AAS, said that the group's current publication the Journal of Astronautics will become increasingly technical and that a new magazine, the Astronautical Sciences Review, will begin publication during the summer to provide a broad semi-technical coverage of the complete field.

General consensus of persons attending the Astronautics meeting last week was the quality of technical papers presented was very high.

Non-Lifting Space Craft

A firm stand for the non-lifting type of manned re-entry vehicle in preference to the hypersonic glider or lifting configuration was made in a paper by two Avco Research Laboratory scientists. These men, Dr. F. R. Riddell and Dr. R. W. Detra, cited the great weight advantage of the spherical or drag type of re-entry body as the main reason they believe it will be an attractive configuration as long as chemical fuel rockets are used to place satellites in orbit.

The addition of wings to a body greatly increases the structural weight needed to carry a given payload. With chemical fuel rocket systems each pound saved in the satellite vehicle can save several hundred pounds in takeoff weight. This will be a dominant factor for years to come, according to the authors.

Principal argument advanced by the adherents of the hypersonic re-entry glider is that the winged vehicle can land at any given airfield. The Avco scientists said their studies show that the problems of bringing a lifting and non-lifting vehicle into the proper descending path are nearly the same order of difficulty. They state that the non-lifting type can be brought within 200 to 300 mi. of a given point using current computing and tracking equipment. Initial re-entry of the winged vehicle would have to be controlled nearly as accurately, according to the authors, to reach any one of a limited number of properly prepared airfields in a dead stick landing.

Space Navigation

Interplanetary navigation probably will employ combination stellar-inertial systems, but will require considerably greater accuracies than now used in aerial navigation and will involve considerably more complexity, according to Edward V. Stearns, manager of guidance department for Lockheed's Missile Systems Division. Space travel navigation is complicated by the fact that it involves six dimensions of the vehicle (three position and three velocity components), six dimensions of the destination, and time, Stearns said.

Typical interplanetary navigation system cited by Stearns would include:

• **Three celestial-body trackers,** capable of tracking the lines of sight to two planets and the Sun with an accuracy of 3 to 5 sec. of arc.

• **Gyro-stabilized platform** for celestial trackers which has gyro drift rates low enough to stabilize trackers during periods of interrupted service.

• **Solar system map** stored in form which is suitable for use by navigation computer.

• **Navigation computer** capable of precise calculations to within a few seconds of arc, or about one part in 100,000.

• **Time accurate to one part** in 100,000 with an operating range of about one year between calibration.

Recombination Powerplant

The idea of obtaining propulsive power from the recombination of free oxygen atoms in the upper atmosphere has progressed to the stage where the first piece of hardware is already under development.

Paul Harteck of Rensselaer Polytechnic Institute is working, under Air Force contract, on a small prototype of a monatomic ramjet. Essentially, this will be a cylinder with an opening of one square yard. The inside of the cylinder will be coated with a solid catalyst to promote the recombination of oxygen atoms. The resultant release of heat will expand the incoming air and create thrust.

Now under the aegis of the Air Force Cambridge Research Center, Dr. Harteck's work was first sponsored by the Air Force Office of Scientific Research. Still interested in the further development of the more basic aspects of this field, the Office of Scientific Research contracted with Aerojet-General Corp.

last year to carry out additional research in this area.

Sterge Demetriades and Carl Kretschmer, who worked on the Aerojet contract, made public the first fruits of their study at last week's meeting of the American Astronautical Society. Among the highlights of their report:

• **Ultraviolet emission** of the Sun causes dissociation of oxygen and nitrogen molecules. These dissociated molecules serve as a storage tank for solar energy in the upper atmosphere (above 60 km).

• **Recombination** of atomic oxygen produces 118 Kcal/mole oxygen; recombination of atomic nitrogen yields 225 Kcal/mole nitrogen.

• **Theoretical estimates** indicate that the recombination of atomic oxygen can be effected in a continuous-flow powerplant by ram compression alone; that is, without a catalyst.

• **Assuming 100% efficiency** in use of the recombination energy, a thrust of 40 dynes per square centimeter of inlet area is obtained at an altitude of 100 km. This thrust is independent of flight speeds and depends only on altitude.

• **Thrusts of 4 dynes** per square centimeter can be obtained with powerplant lengths less than 1,000 ft. At 100 km. this compares favorably with the expected minimum frictional drag for flights at speeds below Mach 10, but this thrust is not sufficient to sustain flight at orbital speeds.

In general, to produce a thrust that is greater than the drag, the recombination powerplant must have a length about 0.7 times the radius. But to insure the recombination of all incoming oxygen atoms, the length would have to be 57 times greater than the radius.

Clumsy and impractical as such a powerplant may seem, it is not to be dismissed entirely. The recombination powerplant, asserted the authors, shows promise for sustained flight on Mars where, it is believed, there is a considerable amount of atomic nitrogen with its higher energy of recombination.

Too, the feasibility of a powerplant using the atomic oxygen above the Earth is not as bad as it looks. As an example, the authors cite the case of an interplanetary ship which, prior to landing on Earth, might decelerate in the atomic oxygen or nitrogen layers and pick up free radicals to be used in its next flight.

The same scheme, they said, could be used on other planets. This significant potential fuel savings on interplanetary flights significantly enhances the feasibility of the recombination powerplant.

USAF, Navy Talk Missile Program

New York—Series of steps leading from current capability to future space weapons was outlined in a progress report on the Air Force guided missile program, presented last week at the annual meeting of the Institute of the Aeronautical Sciences. The spokesman was Maj. Gen. John W. Sessums, Jr., vice commander of the Air Research and Development Command.

After mentioning the many milestones passed during 1957, as activation of Snark and Rascal units in the Strategic Air Command and the successful Thor and Atlas flights, Gen. Sessums got down to some hard facts and some not-so-hard visualizations.

• **On re-entry:** The nose cone test data accumulated in the X-17 research program substantiate theory and indicate that the re-entry problem is solved. In this program, 26 Lockheed X-17 test vehicles were launched; 19 of these successfully fulfilled test requirements. The X-17 attained speeds above Mach 14.

• **On interceptor missiles:** Bomarc approaches the ultimate in automaticity and is being integrated into the SAGE system. Also, it is being programmed to attack targets from a higher altitude; i.e., from above. And a boost in ramjet performance is in the offing. Recently, one of the ramjet engines now under development at Marquardt, pushed a test vehicle to the record speed of Mach 3.95.

• **On propulsion:** Within the next several months, Air Force contractors will test fire the largest solid propellant motors ever made. These engines, in turn, will be surpassed several fold in the near future by new solid motors.

• **On air-to-ground missiles:** The Rascal is but a harbinger. Beyond the Rascal and the new North American air-to-surface missiles lie air-launched ballistic missiles, which will use stable, lightweight and easily handled propellants.

Space Weapons

Opening the door to the space arsenal of the future, General Sessums predicted for offense, there will be the manned hypersonic glide bomber. Launched like a ballistic missile, the bomber will be boosted to an initial speed of 18,000 mph. and an altitude of several hundred thousand feet. It will be able to circumnavigate the globe and glide back home.

Next will be the orbiting "police station." This is the reconnaissance satellite, manned or unmanned, which will keep the Earth under continuous surveillance. And, of course, there will be the space vehicles, operating free of the Earth.

Equally important is the matter of defense against enemy missiles and satellites.

In the case of an enemy ballistic missile, the job of the counter-missile will be to fly up the predicted terminal portion of the target's trajectory and intercept it. If the enemy employs the boost-glide concept, the job, of course, will be more difficult.

The satellite intercept problem is also a knotty one. The pacing element of the counter-missile will be a complex system of ground and airborne electronics to insure automatic intercept and destruction.

To save time in developing this electronic complex, man will be used as an integral part of the control loop.

But this is only the beginning of the technological difficulties. If the counter-missile is behind the satellite, the pilot will have to apply thrust to close the gap. This will increase speed and orbit altitude, possibly to the escape point, and the missile will be thrown into space before reaching the satellite.

Then there is the problem of sighting the target. Optical methods won't work at the projected speeds and near-vacuum altitudes. One answer, suggested Gen. Sessums, might be infrared.

Another difficulty is in the method of directing the missiles fired by the counter-missile to destroy the satellite. Like the counter-weapon itself, these missiles, with a slight increase in velocity, might escape into space. They will have to be directed in a depressed trajectory in order to intercept the target.

Tight Race

As we visualize space weapon systems based on projection of our ballistic missile capabilities, Gen. Sessums declared, man is definitely in the picture.

The United States is in a tight race with Russia. To win, he said, we must take all possible shortcuts. By putting a man in interceptor missiles, it is possible to save up to five years in the development of the required electronic complex.

Sharing the podium with Gen. Sessums were Army spokesman Brig. Gen. John A. Barclay, deputy commander of the Army Ballistic Missile Agency, and Capt. Raymond Thompson who delivered the speech prepared by Rear Adm. John E. Clark, director of the Guided Missile Division, Office of the Chief of Naval Operations. (Admiral Clark had to testify before a Congressional committee in Washington.)

After reviewing the Army's missile arsenal, Gen. Barclay went briefly into the matter of obsolescence ("any weapon as costly and complex as a long-

range ballistic missile should have a minimum operational life of five years") and then on to the problems of propulsion.

One of the main problems here, said the general, is in the use of solid propellant engines in large ballistic missiles. Precise velocity determination by thrust cut-off is essential for guidance accuracy. Aerojet-General and Thiokol are working on this problem for the Army.

One way around this difficulty would be the use of storable liquid propellants. Jet Propulsion Laboratory of the California Institute of Technology is carrying out significant research in this area as well as in the exploration of the potential of exotic propellants for the Army.

The use of prepackaged liquid propellants is also of very much interest to the Navy. According to Adm. Clark, liquid fuels are now being prepackaged in leak-proof containers. Among other things, this means that liquid propellants can be used safely aboard ships in quantities large enough to satisfy ballistic missile requirements. Another advantage of such prepackaged units is that they can be placed on both sides of the motor; and, as they burned, the missile's center of gravity would nevertheless remain fixed.

Looking ahead, Adm. Clark said, the Navy is not restricting itself to the use of rocket motors for ballistic missiles. For example, Navy is currently investigating ramjet engines for possible ballistic applications. The Navy's present ramjet missile, the Talos, is capable of speeds only to about 1,500 mph.; but, said Adm. Clark, Navy scientists believe it is possible to achieve Mach 15 with a ramjet fired at an angle of about 45 deg.

When that day comes, Navy may well decide that free-air propulsion is the most attractive system, even for ballistic missiles.

Adm. Clark laid down this timetable for service use of Navy missiles:

- **Petrel** has been phased out of regular service and into reserve squadrons. There are hundreds of them on the shelf and they would be used if the reserve squadrons were called to duty.
- **Sparrow I** is operational.
- **Sparrow III** will be operational in 1959.
- **Sidewinder** is operational.
- **Bullpup** will be operational in late 1958 or early 1959.
- **Terrier** is operational; an improved version will be operational in 1959.
- **Talos** will become operational this year; an extended range version will be available in 1959.
- **Tartar** will become operational in 1960.
- **Regulus I** is operational.
- **Regulus II** will be operational in 1959.

Overimproved Weapons

New York—Navy experience thus far with the weapon system concept indicates that there is need for considerable monitoring by the customer of projects to ensure that they remain economically feasible, Rear Adm. Robert E. Dixon, chief, BuAer, told engineers during 26th Annual Meeting of Institute of the Aeronautical Sciences.

Contractor's desire to crank improvements into project as it progresses plays havoc with original cost estimates, Adm. Dixon noted, and as a result, budgetary personnel, with no technical knowledge of military requirements, are playing a greater role in final choice of weapons. Unless more effort is made by the contractor to keep costs down, more and more decisions will be made by people incapable of making them, he said. Adm. Dixon indicated that current policies of austerity in defense will be maintained for a considerable time.

- **Polaris** will become operational in 1960.

Talos Automation

Talos antiaircraft missiles can be armed with conventional or nuclear warheads, launched and directed to target by remote control from SAGE (semi-automatic ground environment system) or other air defense centers, D. B. Holmes of Radio Corporation of America told the Institute of the Aeronautical Sciences. RCA, which designed the Talos ground-based guidance and control, has employed automation techniques throughout.

The beam-riding missile is directed by radar during initial portion of flight, switches to semi-active homing for terminal guidance. Talos fire control operator can fire multiple salvos against a single target or can engage multiple targets, Holmes said.

Three-color radar scopes are employed to indicate target-missile status. When target is first assigned, its blip appears in red. When warhead has been selected, blip turns green, subsequently to blue when missile has been launched. Where there are multiple targets, fire control operator pushes buttons to indicate desired sequence of engagement, selects type of warhead. From this point on, the launch and intercept are automatic with the operator serving only as a monitor, Holmes said.

Number of tracking radars at each site are automatically programmed and interconnected as required to meet the specific tactical situation. In event of equipment malfunction, system automatically isolates faulty circuits and interconnects remaining equipments for maximum firepower, Holmes said.

Synthetic attack, programmed on a magnetic tape, can be fed into Talos ground installation and the computed solution compared with the idealized one to check system operation. Comparisons are made on a "go, no-go" basis, with matrix of lights to indicate faulty elements of the system.

Warhead Re-Entry

Problem of insuring that an unsymmetrical and uncontrolled blunt-nosed warhead will not fail in flight because of a tail-first re-entry or self-induced accelerations was treated in a paper by Joseph D. Welch and S. L. Shih of the General Electric Co.

The paper dealt with the proper re-entry alignment and damping of warhead oscillations which must be accomplished between 500,000 and 200,000 ft. altitude before heating and drag become too great. It was not restricted to planar motion, but considered three degrees of angular freedom.

The small aerodynamic moments generated in this altitude range are of consequence because the angular velocities of a warhead tumbling and rolling in from space are considered to be relatively small. Aerodynamic lift and drag were ignored because they are so small in relation to the tremendous warhead velocity.

Initial angular velocity or any mass dissymmetry of a warhead entering the 500,000 ft. level can lead to gyroscopic coupling that can restrict the movement of the body around certain axes. This effect can be of benefit to the designer by giving him a means of guaranteeing the proper re-entry attitude of the warhead, but it also can result in its failure, according to the paper. The authors discussed the theory and called for more design data.

Main warhead example concerned the typical body having a much larger moment of inertia around the pitch and yaw axes than in roll. During the typical re-entry this body would have a roll velocity which would cause an inertial coupling. Under a fairly wide range of relative values for the gyroscopic coupling moment, the aerodynamic moment and initial roll rate, the warhead would spiral or wobble. As dense air is reached this wobbling, if it is of large magnitude, could raise heating and lateral accelerations to destructive levels before dynamic pressure and damping increased enough to stabilize the warhead and stop the wobbling motion.

The authors also point out that the use of mass dissymmetry can stop rearward stabilization, which is possible with all but spherical warheads, and prevent a tail-first re-entry. The desired forward stabilization can be maintained if the inertial moment due to mass dissymmetry is greater than the aerodynamic moment trying to stabilize the warhead in rearward flight.

NACA Urges National Space Program

By Evert Clark

Washington—National Advisory Committee for Aeronautics' proposal for a comprehensive national space flight program is expected to gain wide industry, military and scientific support. Its success will depend upon its acceptance in Congress, where several conflicting plans already have been proposed.

NACA's plan also appears to have strong backing in key parts of the executive branch of the government.

Essence of the proposal is that "a major, coordinated national effort" must begin immediately, making maximum use of existing agencies and facilities and covering civilian as well as military aspects of space conquest.

Logical pattern for the future is the one followed successfully by NACA in its teamwork with industry, the sciences and the military services over the past 42 years, NACA said.

National Science Foundation and the National Academy of Sciences would plan scientific experiments, assign priorities for basic research on space phenomena.

National Science Foundation also would provide financial support for scientists "in the detailed planning, design and construction of special apparatus, related research and analysis of data for approved projects."

NACA Role

NACA would conduct flights for scientific purposes by itself when it could, or jointly with agencies of the Defense Department, as it has with research aircraft since 1947.

It also would "coordinate and conduct research in space technology in its own laboratories and by contract in support of both military and non-military projects."

This would require "a rapid expansion" of NACA's staff, contract research program and existing laboratories and construction of new facilities—including a launching site and a network of observation stations.

The National Advisory Committee for Aeronautics itself unanimously adopted a resolution last Jan. 16 setting forth the program and stating that "the urgency of an adequate national program of research and development leading to manned satellites, lunar and interplanetary flight is now apparent."

Outlining the program to the Institute of Aeronautical Sciences in New York last week, NACA Director Hugh L. Dryden said in a speech delivered by NACA Executive Secretary Dr. John Victory that the committee "has been engaged increasingly in research applicable to the problems of space flight" since the end of World War II.

In addition to the X-15 rocket research aircraft, he said, NACA is "engaged in studies of satellite configurations suitable for safe re-entry at still higher speeds, both for manned and unmanned flight."

But "the present program is far from adequate," Dryden said. "Our rate of progress in solving the problems of space flight must be very greatly increased."

Doolittle's Warning

Dr. James H. Doolittle, NACA chairman, said in a letter to Congress—written three days before Russia launched her first Sputnik—that "the pressure for governmental economy, coupled with the effect of rising costs, has resulted in the general level of NACA research effort compared to that of the Soviets being lessened when it should be increasing. Thus America's relative position in aeronautical science has been deteriorating. There is an urgent need at this time for a genuine increase in the level of research effort."

Dr. Dryden told Congress last year that NACA's 28 technical committees had urged a 25% increase in effort and that a budget request had been prepared accordingly. But, he said, the Budget Bureau then cut $26.3 million from the $148 million request and denied NACA's supplemental budget request in full for the first time in years.

NACA's recently created Special Committee on Space Technology will hold its first meeting Feb. 13 to review needed research and development and formulate a program for NACA's future efforts in space flight.

Major Research Fields

NACA listed these major research fields which must be more thoroughly explored:

- **Space mechanics.**
- **Space environment.**
- **Energy sources.**
- **Propulsion systems.**
- **Materials.**
- **Launch, rendezvous,** re-entry and recovery.
- **Communication, navigation** and guidance.
- **Vehicle configuration** and structure.

Backers of NACA Plan

Washington—Members of the National Advisory Committee for Aeronautics who unanimously approved the Jan. 16 resolution calling for a national space flight program were:

- **Dr. James H. Doolittle, chairman of NACA and the USAF Scientific Advisory Board and vice president, Shell Oil Co.**
- **Dr. Leonard Carmichael, NACA vice chairman and secretary of the Smithsonian Institution.**
- **Preston R. Bassett, former vice president of Sperry Rand Corp.**
- **Dr. Detlev W. Bronk, president of the National Academy of Sciences and National Research Council; chairman of the National Science Board; member, President's Committee on Scientists and Engineers.**
- **Vice Adm. William V. Davis, Jr., deputy chief of naval operations for air.**
- **Dr. Paul D. Foote, Assistant Secretary of Defense for Research and Engineering.**
- **Rear Adm. Wellington T. Hines, assistant chief of the Bureau of Aeronautics for procurement.**
- **Dr. Jerome C. Hunsaker, professor emeritus of aeronautical engineering, Massachusetts Institute of Technology; Board of Regents, Smithsonian Institution, and former chairman of NACA.**
- **Charles J. McCarthy, chairman of the board, Chance Vought Aircraft, Inc.**
- **Lt. Gen. Donald L. Putt, USAF deputy chief of staff for development; military director, USAF Scientific Advisory Board.**
- **James T. Pyle, Civil Aeronautics Administrator.**
- **Louis S. Rothschild, Undersecretary of Commerce for Transportation, member Airways Modernization Board.**

NACA members absent when the resolution was approved:

- **Dr. Allen V. Astin, director of the National Bureau of Standards; member of the Interdepartmental Committee on Scientific Research and Development.**
- **Frederick C. Crawford, chairman of the board, Thompson Products Inc.**
- **Dr. Francis W. Reichhelderfer, chief of the U. S. Weather Bureau, member of the Interdepartmental Committee on Scientific Research and Development.**
- **Edward V. Rickenbacker, chairman of the board, Eastern Air Lines Inc.**
- **Gen. Thomas D. White, USAF chief of staff.**

NACA Space Committee

Washington—Members named thus far to the Special Committee on Space Technology of the National Advisory Committee for Aeronautics (AW Jan. 13, p. 29) are:

- Dr. H. G. Stever, associate dean of engineering, Massachusetts Institute of Technology; vice chairman, USAF Scientific Advisory Board.
- H. Julian Allen, Ames Aeronautical Laboratory, NACA.
- Dr. Hendrik W. Bode, director of mathematical research, Bell Telephone Laboratories.
- Dr. Milton U. Clauser, director of aeronautical laboratory, Ramo-Wooldridge Corp.
- Prof. Dale R. Corson, Cornell University.
- James R. Dempsey, manager, Convair-Astronautics Division, General Dynamics Corp.
- Robert R. Gilruth, assistant director, Langley Aeronautical Laboratory, NACA.
- S. K. Hoffman, general manager, Rocketdyne Division, North American Aviation, Inc.
- Dr. W. Randolph Lovelace II, Lovelace Foundation for Medical Educational Research.
- Dr. William H. Pickering, director, Jet Propulsion Laboratory, California Institute of Technology.
- Dr. Louis N. Ridenour, Jr., Missile Systems Division, Lockheed Aircraft Corp.
- Abe Silverstein, associate director, Lewis Flight Propulsion Laboratory, NACA.
- Dr. James A. Van Allen, Department of Physics, State University of Iowa.
- Dr. Wernher von Braun, director, Development Operations Divisions, Army Ballistic Missile Agency.

- **Space biology.**
- **Flight simulation.**
- **Measurement and observation** techniques.

NACA's program apparently would not conflict with Defense Department's Advanced Research Projects Agency, based on what is now known of ARPA's proposed function. It might, however, limit the need for ARPA to become an operating agency, since it seems to advocate farming out of as much space research and development as possible to the services, NACA, industry and scientific institutions.

Conflicting proposals have called for new, independent government agencies to perform either the civilian or civilian and military aspects of research, and development for space; handling of this work by the Atomic Energy Commission; creation of a whole Department of Science, etc.

Dissatisfaction in industry and the military with the vagueness of Defense Department's plans for ARPA and the widely expressed feeling that existing agencies must be used so time is not wasted in the formation of new ones, would indicate that NACA's proposal might find wider support than any other specific program outlined so far.

Membership of the committee (see box, p. 32), which adopted the space age resolution unanimously, also indicated wide acceptance in government, industry and scientific circles.

But the congressional battle for control of whatever becomes the nation's "space agency" promises to be a critical factor in the future of NACA's proposal.

Senate Group Asks White House Action

By Ford Eastman

Washington—Senate Preparedness Subcommittee members said last week it will be up to the White House and Defense Department to take action on the 17 recommendations it proposed to bolster the nation's defenses.

Subcommittee members said, however, they will cooperate with the Administration in pushing any legislation needed to implement the various proposals.

Interim Report

The recommendations were contained in an interim report issued at the conclusion of the subcommittee's investigation into the U.S. satellite and missile lag behind the Soviet Union. A more detailed report is expected to be ready within a few weeks.

Sen. Lyndon Johnson (D.-Texas), subcommittee chairman reported that, during the hearings, more than 70 witnesses appeared and about 200 experts were interviewed.

Most of the recommendations and findings were made last year by the Senate Subcommittee on the Air Force but received little public attention in the pre-Sputnik era.

The 17 areas upon which the subcommittee said "decisive" action must be taken:

- **Modernize and strengthen** the Strategic Air Force.
- **Accelerate the dispersal** of SAC bases.
- **Put more effort into developing** anti-missile missiles.
- **Improve the early warning system** for manned aircraft and accelerate the development of an early warning detection system for ballistic missiles.
- **Modernize and strengthen** ground and naval forces.
- **Provide an adequate airlift** for ground troops.
- **Pour more effort into** our anti-submarine program.
- **Accelerate production schedules** of Atlas, Thor, Jupiter and the development of Titan.
- **Reduce lead time** in the development of weapon systems by cutting down on decision time and simplifying procurement procedures.
- **Provide for a freer exchange** of scientific and technical information between the nations of the free world.
- **Begin immediate development** of a 1,000,000 lb.-thrust rocket motor.
- **"Give serious attention"** to the question of shelters and stockpiles for civil defense.
- **Reorganize the structure** of the defense establishment.
- **Provide increased incentives** for the retention of trained personnel in the military services.
- **Accelerate and expand research** and development programs, provide funding on a long-term basis, and improve control and administration within the Department of Defense or through the establishment of an independent agency.
- **Put more effort into** the development of manned missiles.
- **Accelerate the development** of the Polaris missile system.

Sen. Johnson explained that the subcommittee's responsibilities are limited to defense, but said the U.S. has reached a stage where defense involves the total effort of a nation. He said the subcommittee was led into fields that will have to be explored more fully by others with proper jurisdiction and with greater background.

Unanimous Vote

The proposals made at the conclusion of the hearings were adopted by a unanimous vote of the subcommittee.

"There is nothing in the record," the report said, "to indicate that America has lost its vitality or its capacity to produce in time whatever we need to retain our present power to strike devastating blows—blows of almost total destruction—at any aggressor."

It added that there is evidence that the Russian satellites, although not weapons now, have two important im-

plications. They demonstrate beyond question that the Soviet Union has the propulsion force needed to send a missile from one continent to another, and the Soviet Union has gathered basic information about outer space.

In investigating the questions raised by these facts, the report said, testimony of top scientists, leading industrialists and government and military officials, reveal:

- **That the Soviet Union** leads the U. S. in development of ballistic missiles.
- **That the Soviet Union leads** the U. S. in the number of submarines, which raises the possibility of attack with modern weapons or missiles, although indications are that the U. S. is ahead in the production of atomic-powered submarines.
- **That Russia is rapidly closing** the gap in manned airpower and, at present rates, will surpass this country in a comparatively short time.
- **That Russia is producing scientists** and technicians at a rate substantially greater than our country.

U. S. Reaction

The report said that since Sputnik I was put into orbit on Oct. 4, the Defense Department has taken the following actions:

- **Overtime restrictions have** been removed from ballistic missile programs and some other high priority programs.
- **Basic research projects** have been restored to former levels.
- **Army has been ordered into** the satellite program.
- **Production of the Thor** and Jupiter intermediate range ballistic missiles has been authorized.
- **Development of the Atlas** intercontinental ballistic missile has been accelerated.
- **Development of Navy's Polaris** fleet ballistic missile system has been accelerated.
- **Army has received a go-ahead** for developing a solid propellant tactical missile, the Pershing.
- **An Advanced Research Project** Agency has been authorized by Defense Secretary Neil McElroy to oversee space and anti-missile projects.
- **An Office of Director** of Guided Missiles is now in being.
- **Development of anti-submarine** warfare capability has been accelerated.
- **Steps to disperse** SAC are under way.
- **Air Force has been authorized** to go ahead with its long-range missile detection system.
- **Army has been assigned** the task of developing an anti-missile missile.
- **Secretary of Defense** has appointed consultants and promised to come to Congress as soon as possible with recommendations to improve the defense establishment through organizational changes.

German Defense Minister to See McElroy on Aircraft, Arms Choice

Bonn—West German Defense Minister Franz Josef Strauss flies to the U. S. on Mar. 11 for a two week information visit.

He will be the guest of U. S. Defense Secretary Neil McElroy.

Object of Strauss' trip will be to check on planes, tanks and other equipment for Germany's military forces and to review defense problems. Question of stationing IRBMs on German soil is not on the agenda but undoubtedly will be discussed, at least informally. A decision on where to spot IRBM bases in Europe is expected at a NATO defense ministers' meeting toward the end of March.

Biggest procurement plum still pending is a decision on an advanced interceptor for the German air force. The Lockheed F-104A and the Grumman F11F-1F are still front-runner, but the field, which had virtually narrowed to those two, has been widened again to include the Chance Vought F8U-1, Britain's English Electric P.1B which is being test-flown this week by a German team, Sweden's SAAB-35, unflown by the Germans but now slated for a trial, and Northrop's N-156F.

May Test SAAB

A mission may be sent to Sweden to test-fly the SAAB following repeated requests from Stockholm.

However, chances for an order to a non-NATO country are regarded as relatively slim.

Only the Saunders-Roe SR. 177 has been rejected outright, as result of the English firm's demand for "yes" or "no."

Absence of a clear-cut American position on an advanced interceptor, not pressure, as charged by the British after German rejection of the Saunders-Roe SR. 177, is a major problem to the Germans in reaching a decision, U. S. military officials here believe.

A team of German air force experts headed by Chief of Staff Lt. Gen. Josef Kammhuber will fly to Washington on Feb. 7 for technical talks aimed at clarifying a welter of aircraft company claims and counter-claims. Although the number of planes to be bought has varied from 100-odd to 400, value of the contract will easily top $100 million.

Merit to Count

Defense Ministry officials insist decision will be based entirely on merit, but political considerations have played a part in delaying placement of much-sought order.

Both England and France are anxious to fatten their foreign currency reserves, and American manufacturers would like to recoup from 1957 USAF stretch-outs and cancellations.

Interceptor decision, which was originally slated prior to Dec. 31, then postponed until this month, seems unlikely before the end of March.

Germans are now asking prospective suppliers for additional technical data, as well as reviewing flight data accumulated to date.

F-104As Operational Soon

Lockheed Aircraft Corp.'s F-104As will become fully operational at Air Defense Command's Hamilton Air Force Base near San Francisco, Calif., within a month.

F-104 Starfighters will be armed with wingtip-installed Sidewinder guided missiles.

Hamilton AFB is headquarters for the Western Air Defense Force, commanded by Maj. Gen. Hugh A. Parker.

Northrop Reveals T-38 Fighter Details

Northrop N-156F, fighter version built on basic T-38 configuration, is scheduled to have a range of more than 1,700 nautical miles with external tanks.

Takeoff weight will be 11,500 lb. as compared with 10,900 lb. for the trainer version; wing span is 26 ft. 5 in., with wingtip armament.

The overall length is 41 ft. 7¼ in.—42 ft. 8 in. for the T-38. Height is 13 ft. as compared with 11 ft. 11 in. for the T-38.

In addition to boundary layer control, the N-156F will have air load-actuated leading edge slats. A drogue chute will be used to shorten the landing run.

Aileron and rudder feel will be afforded by control force springs. Longitudinal feel will be by combination of control force spring and bobweight. Longitudinal and directional stability augmentors will be used in series with control systems.

Speed brakes will be located on underside of fuselage forward of main landing gear doors.

Skid, surfaced with Teflon, will supplement oversize tires for operation from sod runways. Skid is projected to serve the same function as a dual wheel installation at reduced weight and volume for stowing.

GLOBAL GUARDIAN—Nowhere can an aggressor take refuge from America's mighty instrument of retaliation, the Northrop Snark SM-62... world's first intercontinental guided missile, now scheduled for delivery to the Strategic Air Command of the U.S. Air Force. These pilotless bombers are designed to carry nuclear warheads with unerring accuracy over intercontinental ranges. Snark missiles can be launched in mass from sites thousands of miles from their targets. This forceful deterrent to attack is an existing product of Northrop's "years ahead" engineering. Missiles, drones, supersonic jet aircraft, ground support and armament equipment, integrated weapon systems and other vital national defense elements are being developed and produced at Northrop, where simplicity and economy are vital elements in the continuing search for weapon systems to guard tomorrow's free America.

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Congress Draws Battle Lines For Outer-Space Control

Washington—A three-way fight over political and administrative control of outer-space research and development has developed among leaders on Capitol Hill.

On one point all three factions concur: control should be with a civilian agency. They would pull power out from under the Advanced Research Projects Agency which Secretary of Defense Neil McElroy proposes to establish to give military direction to outer-space development (AW Jan. 27, p. 21).

Three Proposals

The three proposals, each with powerful backing, are:

• **Establishment** of a Department of Science and Technology, headed by a cabinet-level Secretary, which would give policy direction to all civilian scientific functions. This legislation is sponsored by Sen. John McClellan (D.-Ark.), chairman of the Senate Committee on Government Operations, with jurisdiction over the re-alignment of government functions, and by Sen. Hubert Humphrey (D.-Minn.), chairman of the subcommittee on reorganization.

• **Establishment of a five-member** presidentially-appointed National Science Council to direct outer-space and all other specific projects of the government—civilian and military. The position of Rep. John McCormack (D.-Mass.), House majority leader, who introduced and is pushing this measure is that a new Department and Secretary of Science and Technology would simply create another layer of bureaucracy and end in a stalemate: it would have only co-equal authority with the Department of Defense, leaving final decision on controversial policies to the President. McCormack is a member of House Government Operations Committee which has been conducting hearings on the general subject of a federal science program. A companion proposal, introduced by Rep. William Dawson (D.-Ill.) chairman of the House Government Operations Committee, would set up a $200 million scientific research reserve fund, which would take financial control of scientific projects from budget and accounting experts. The fund would be administered by the National Science Board of the National Science Foundation to give continuing support to high-priority projects and eliminate the present practice of starting and stopping projects with the fluctuations of fiscal requirements.

• **Establishment** of a Division of Outer Space Development in the Atomic Energy Commission. This has the substantial backing of the Joint Atomic Energy Committee and was introduced in the House by Rep. Carl Durham (D.-N. C.), the chairman, and in the Senate by Sen. Clinton Anderson (D.-N. M.), vice chairman.

Moving rapidly to capture jurisdiction over the emerging field of outer-space, the Committee set up a Subcommittee on Outer Space Propulsion, headed by Anderson, and including Sens. Henry Jackson (D.-Wash.), Albert Gore (D.-Tenn.), Bourke Hickenlooper (R.-Ia.), and Reps Chet Holifield (D.-Calif.), Melvin Price (D.-Ill.), James Van Zandt (R.-Pa.), and James Patterson.

Backers of the McClellan-Humphrey legislation are vigorously opposing the "grab for authority" of the Atomic Energy Committee. They claim that there is little more reason for turning outer-space policy control to the AEC than there is for turning it over to the Department of Agriculture. The McClellan-Humphrey proposal would supplant the Joint Atomic Energy Committee with a House and a Senate Committee on Science and Technology, and AEC would become a branch of the new Department.

The proposal of National Advisory Committee for Aeronautics to obtain authority over a comprehensive outer-space program (see p. 32) has not yet received official attention on Capitol Hill.

The new Department, in addition to coordinating and directing science programs would administer a scientific scholarship program and establish national institutes for basic scientific research. It would take over the present science functions of numerous government organizations—National Science Foundation, Commerce Department, Bureau of Standards, Smithsonian Institution.

Sen. Anderson argued that the advantages of establishing a new department or agency to direct outer-space programs are outweighed by the disadvantages. He commented:

Advantages of New Agency

"The advantages of a new agency could be in the desirability of fresh approach and new administration to cope with a unique problem. A new agency lives in a fresh political climate free from the disputes of other years, and it could prosper in this climate. In addition, the policy for space for peace would be fostered by removal from any association with the military or with weapons research present in some existing agencies.

"But time, which may be of the essence, would be lost in staffing and in building facilities. Short of an expensive crash effort, up to two years could be lost. . . .

"One problem today is that we have so many executive agency committees and other groups in scientific and technical affairs, and the creation of a new agency would seem to lead to additional confusion and possible rivalry.

"The alternative is placing jurisdiction in an existing civilian agency. There may be several from which to choose but the Atomic Energy Commission appears to be the most logical choice. The AEC nuclear rocket project —Project Rover—provides a basis for further efforts at large scale nuclear propulsion. There is ample scientific evidence that nuclear propulsion offers the best hope for propulsion of a space vehicle with its powerful and long-lived fuels and tremendous power potential. But even without this, an assignment to the Commission is tempting because it is a going agency and has the best laboratory complex in the nation, perhaps the world." NACA would serve in an advisory capacity to AEC on space programs.

News Digest

Reaction Motors Inc. and Thiokol Chemical Corp. agreed to a merger last week, continuing the trend toward consolidation of talent and facilities in the missile propulsion field (AW Jan. 20, p. 34; Jan. 27, p. 33). RMI stockholders will get one share of new Thiokol stock for each 1¼ shares RMI stock they now hold.

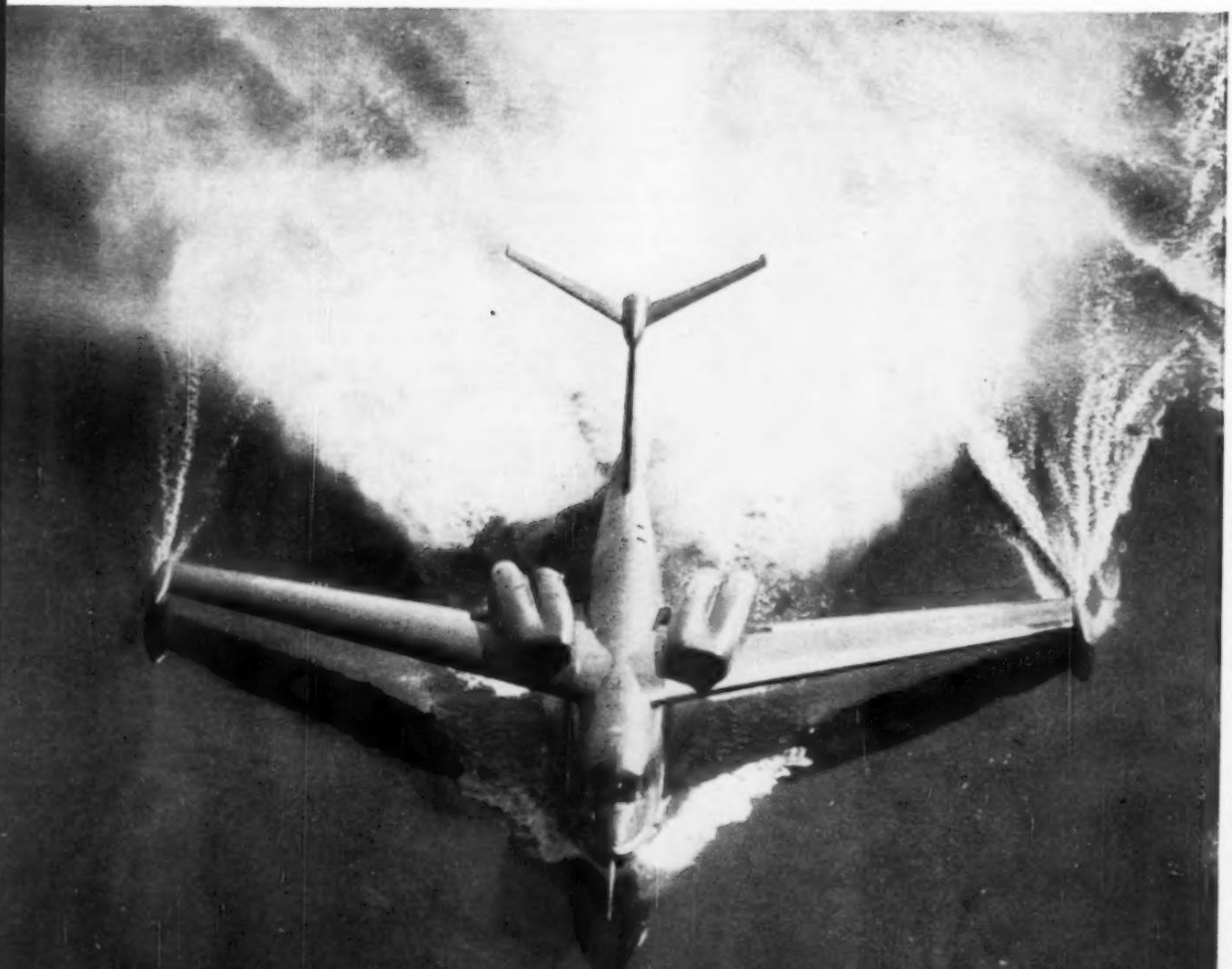
Aerojet-General Corp. expects to add 1,000 professional and skilled workers at its Sacramento, Calif., plants by next June. About one-fourth of the new employes will fall in the professional class. Company currently employs about 7,000 people at Sacramento.

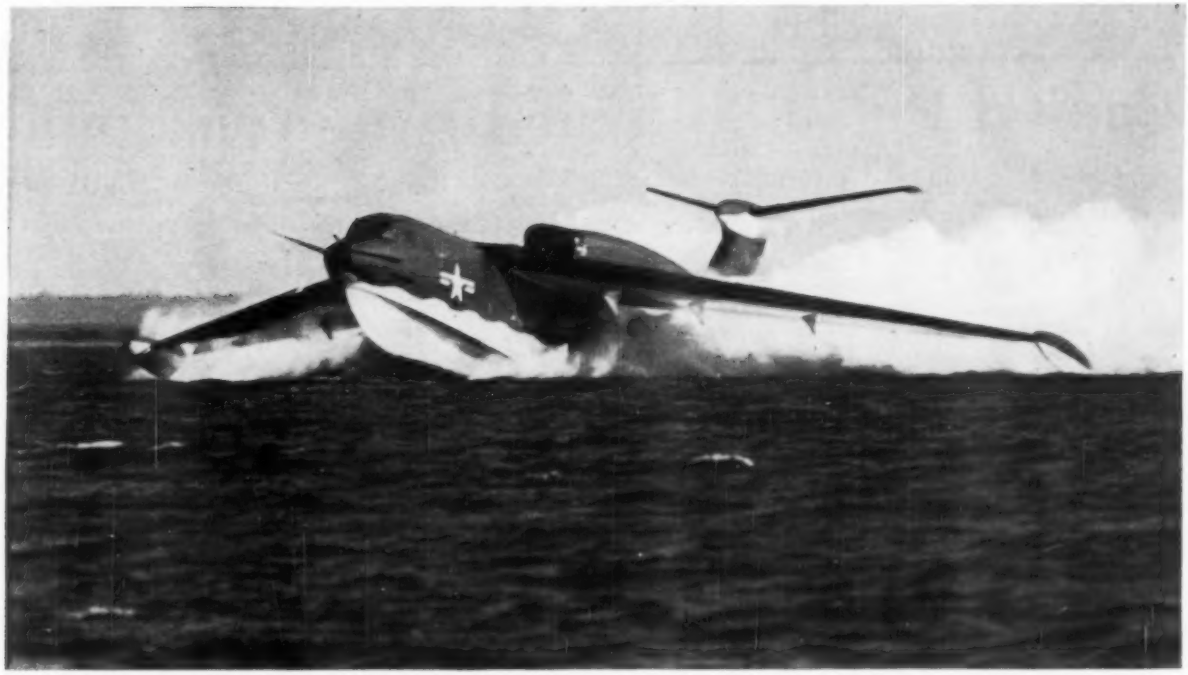
Solar Aircraft Co., in a move aimed at strengthening its missile contract bids, has merged with Norden-Ketay Corp., avionics firm, hard hit by defense cutbacks. Solar's stock is being picked up by Budd Manufacturing Co. with view toward possible merger.

Strategic Air Command set a new flying safety record in 1957 with five major and minor accidents per 100,000 hr. flown. Previous low rate was nine, achieved in 1956.

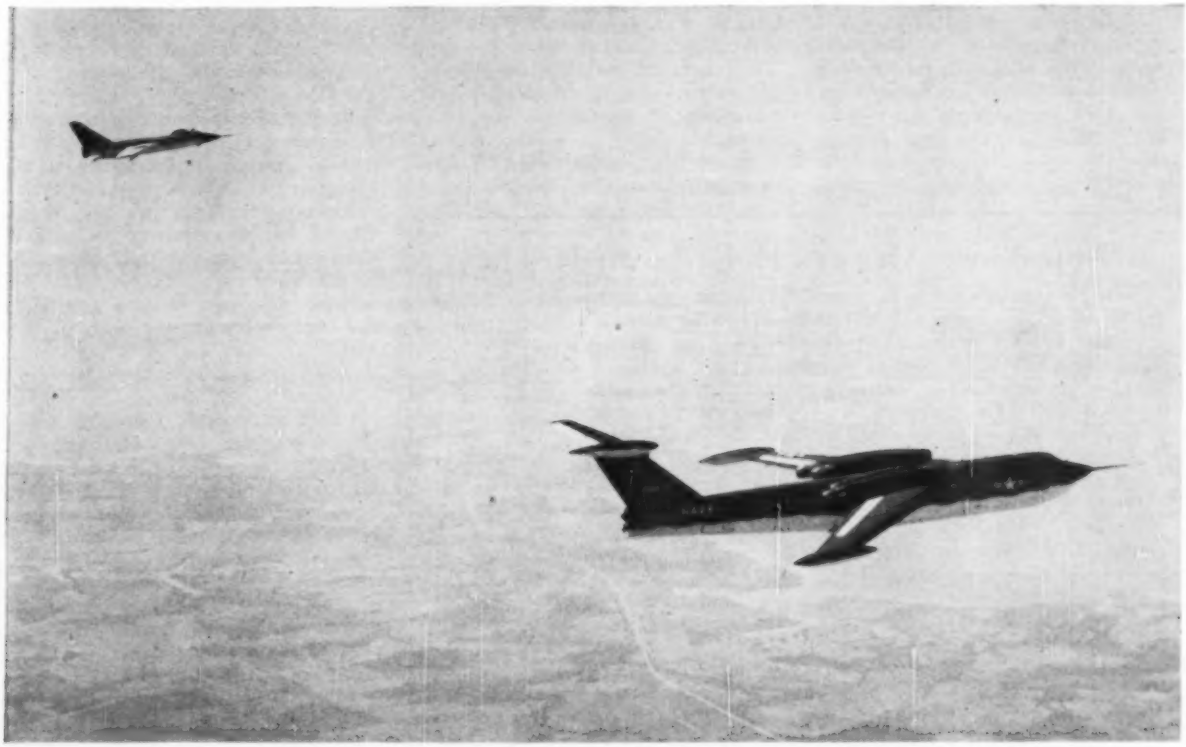
Breguet, French aircraft firm, is ready to fly the second prototype of its Breguet 1001 Taon, lightweight ground attack fighter.

Third Prototype P6M Makes First Flight





Several important modifications are visible in these first pictures of third prototype Martin SeaMaster taking off on its initial test flight near Middle River, Md. (AW Jan. 27, p. 35). Side view (top left) shows redesigned bullet at junction of T-tail having a deeper cross section than on two previous XP6M-1s. Also noticeable is a canted fairing under the bullet to reduce inflight drag. Martin engineers have visibly canted four afterburner-equipped Allison J71 engines outwards to eliminate afterbody heating problem encountered on XP6M-1s. Also shown is redesign of front of engine nacelles to provide more even airflow distribution across engine compressor facings. Navy program for SeaMaster calls for eight YP6Ms with J71s; 18 P6Ms with P&W J75s. SeaMaster has an unrefueled range of 1,500 mi., speed of over 600 mph. with 15-ton payload.



YP6M-1 SeaMaster is escorted by supersonic Grumman F11F-1 Tiger chase plane during its recent two-hour first flight. Two earlier XP6M-1s compiled 75 hr. flight time before they were destroyed as a result of malfunctions in the tail system.

Capital Puts 880 Near Breakeven Point

Convair's financial guarantee in turn offers airline an answer to pressing fiscal, equipment problems.

By Glenn Garrison

New York—Capital Airlines may have found a way out of its equipment and fiscal troubles by purchase last week of nine-15 Convair 880 jets with a financial assist—but not necessarily cash—from the manufacturer.

General Dynamics Corp., whose Convair Division is building the plane, also improved its commercial 880 prospects with the $60 million sale by approaching the breakeven point.

The manufacturer has agreed to help Capital find money not only to pay for the 880 order but to re-finance the airline's existing $48.5 million debt for Vickers Viscount equipment. The Convair builder also is aiding Capital by arranging piston equipment leases to tide the airline over the interim until the jets are delivered.

Delivery in 1960

Plans call for first deliveries under the 880 order in September, 1960, with the rest of the planes arriving over the succeeding year. Nine of the four-engine jets are needed for its present system, Capital says, with the other six contingent on future expansion. The airline is seeking two new routes in the Great Lakes Service Case, and the equipment order makes at least one of the routes appear promising for Capital. Oral argument in the case began last week.

Fifteen planes to Capital would put total orders for the Convair jet at 63. Lambert J. Gross, vice president-finance of General Dynamics, told AVIATION WEEK that breakeven point for the plane "can't be nailed down that closely," but that the sale "may well put us in the ball park."

The two firms, Gross said, have reached an understanding whereby General Dynamics will lend Capital "reasonable assistance" with its financing problems. After reviewing the airline's problems, General Dynamics concluded that with the 880 serving Capital's routes, the problems could be straightened out without great difficulty.

Financing Plan

Details of the financial arrangements were not final, Gross said, but it is "not contemplated to provide cash money out of our coffers."

General Dynamics would go part way in guaranteeing outside loans to Capital.

A spokesman for the airline said, however, that if outside financing could not be arranged, the agreement calls for General Dynamics to provide money.

Concerning any extension of direct credit to Capital for the 880s, Gross said such a possibility was remote. He said Convair contemplates selling the plane to Capital on the same basis as to any other customer as far as payments are concerned, with the normal cycle of down payment, progress payments, and final payments.

Purchase of the 880s will permit Capital to operate competitive equipment on all its major routes, the airline's president, David H. Baker, told AVIATION WEEK. The airline's 59 Viscounts can be used more efficiently throughout the system, and Capital can get rid of some of its money-losing 12 DC-4s, 18 DC-3s, and 12 Lockheed 049s.

Great Lakes Routes

The new Convairs would go on the Buffalo-Miami and Detroit-Miami routes if Capital gets them in the Great Lakes Case. The Civil Aeronautics Board examiner in the case recommended last summer that Capital be awarded the Buffalo-Miami route, then withdrew the recommendation last November. The examiner suggested then that if the airline had competitive equipment to serve the route, he would return to his original position and recommend Capital. In the meantime, National Airlines was recommended for Buffalo-Miami. Capital also is seeking the Detroit-Miami run.

Both routes, Capital contends, are absolutely essential to the airline's system to provide a seasonal balance to the pattern.

Since the 880 order was announced, Capital has withdrawn its request to CAB for a return to subsidy. The Board's decision to allow a 6.6% fare increase, of course, is another factor in the carrier's brightening financial outlook.

Apparently as a result of these developments, the airline's stock has climbed significantly. Last week it rose from $10 to $16.

Frank Pace, president of General Dynamics, last week was to send a telegram to CAB confirming the purchase by Capital.

The 880 purchase agreement did not involve General Electric, manufacturer of the CJ805 (J79) turbojet which will power the plane, according to both General Electric and General Dynamics. Gross said, however, that GE might possibly come in at some stage in the proceedings.

Arrangements for leasing piston equipment are "fairly well along," the General Dynamics official said. The cor-

New York Airways Decides on H-44s

New York Airways last week confirmed its previously expressed interest in the Vertol 44B by announcing a decision to buy five of the tandem-rotor machines.

Present fleet of Sikorsky S-55s and S-58s are being sold, President Robert L. Cummings, Jr., said, but final arrangements have not yet been made. The Vertol order, scheduled for delivery beginning in April, is "subject to the satisfactory conclusion of discussions now under way with the Civil Aeronautics Board."

New York Airways commissioned William Wold Associates, New York aircraft broker, to sell its Sikorsky fleet. As of last Wednesday, no actual sale had been made, according to industry sources.

Wold has offered the New York Airways fleet to helicopter operators all over the world. At the recent American Helicopter Society meeting in Dallas, printed notices of the offering were circulated and a number of operators were approached without any takers being found.

The helicopter package, which includes tools and training, was also offered to overseas operators including Japanese. Chicago Helicopter Airways was approached, but that operator has just bought two new S-58s. Los Angeles Airways also was approached.

A year ago prospects of selling the rotorcraft to offshore oil operators along the Gulf Coast might have been good, but an over-supply of crude oil now has resulted in a lull in this activity. What had been a brisk market for helicopters has become very slow as a result.

Bristol Seeks U. S. Jet Sales

Model of Bristol 200 shows mounting of three jet engines on tail of the short-range transport. British European Airways has delayed its decision on the aircraft (AW Jan. 27, p. 39) pending study of a new financial proposal by de Havilland Aircraft and the outcome of the U. S. sales talk by the combined team of Bristol Aeroplane Co. and the Hawker Siddeley Group. Industry sources said a decision favoring the de Havilland 121 was delayed when Hawker-Bristol team reported U. S. interest, particularly by Pan American World Airways. But a PanAm spokesman said, "We look at every airplane, are interested in every airplane but have no special interest in the Bristol 200."

poration is handling the leasing as a service to Capital only, adding it to the sales package.

Capital would need some long-range equipment to cover a route or routes to Miami.

But leased aircraft could meet its interim requirements until delivery of the 880s.

As to possible financing of new transports through credit arrangements between manufacturer and airline customer, Gross considers such a trend unlikely.

Capital requirements of the aircraft industry are so great, he pointed out, that "we couldn't go very far down that road."

'Nothing Unique'

The agreement with Capital concerning the 880 purchase is "nothing unique or dramatic," Gross said. Sales of Convair 440s to Latin American countries, he noted, have been handled on a similar basis in the past, with General Dynamics arranging the financing through commercial banks and, where necessary, partially securing the loans.

Regarding possible agreements with other potential 880 purchasers for the kind of help Capital will get, Gross said "there is nothing in the works which has reached the same degree of maturity" as yet.

Capital's 880s will be in 94-passenger mixed configuration, according to the airline.

House Unit Plans CAB Probe

Washington—House Special Subcommittee on Legislative Oversight indicated last week that it will investigate airline entertainment of Civil Aeronautics Board officials.

In another area, the subcommittee headed by Rep. Morgan M. Moulder (D.-Mo.) will look into two route awards in which the President overruled the Board's recommendations and asked for an amended order. Cases involved are the North Atlantic Case and the Transpacific Case.

Subcommittee hearings opened last week with a general inquiry into the regulatory agencies to determine if they are being administered as Congress intended. Other agencies involved besides the CAB include the Federal Communications Commission, Federal Trade Commission and the Securities and Exchange Commission. This week, the subcommittee is expected to go into "specifics."

Following the first day of general questioning last week, the House investigated staff evidence that airline executives have "lavishly" entertained members of the CAB. The report said investigators were examining the books of country clubs in the Washington area and questioning airlines to determine the amount of money spent on entertainment of CAB officials.

The only hint at the beginning of the hearings of possible "wrong doings" in connection with the CAB was made by Subcommittee Counsel Bernard Schwartz during the questioning of CAB Chairman James Durfee. Schwartz asked Durfee if he felt it improper for any one party in a case to argue its cause privately with the executive branch in international air route cases.

Rep. John W. Heselton (R.-Mass.) objected to the question on the basis that no evidence had been introduced that such a conversation had taken place. Schwartz replied that he was prepared to offer background material and that the subcommittee will go into more specific matters at a later date.

Most of the questions asked Durfee centered around what effect, if any, Section 801 of the Civil Aeronautics Act had on the independence of the CAB.

Section 801 states that all decisions pertaining to a U. S. carrier seeking to engage in foreign or overseas air transportation is subject to approval by the President. It was included in the act in order that the President might retain his authority over all foreign policy matters, which award of air routes might affect.

Under Section 801, the CAB conducts a route case proceeding in the same manner as domestic cases except that it forwards its findings and recommendations to the President for final approval.

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Domestic Lines Dispute CAB Fare Offer

By L. L. Doty

Washington – Domestic trunklines last week challenged a Civil Aeronautics Board offer to approve a temporary fare boost of 6.6% as "too little and, perhaps, too late."

Although the majority of the nation's 12 domestic trunk carriers late last week had indicated their intention of accepting the Board's invitation, the offer attracted no immediate rush of tariff filings for the increase. A few airlines took the attitude that "it is better than nothing" but at least two major airlines hinted strongly that they were completely dissatisfied with the proposed fare hike.

Earlier last month, five airlines had filed for fare increases ranging from 12% to 15% as the absolute minimum needed immediately to arrest the industry's deteriorating financial condition (AW Jan. 27, p. 38).

Latest action in the long drawn-out fare case stems from a Board announcement that it would permit an across-the-board 4% fare increase on all fares plus an extra $1 charge on all tickets. The revised tariff structure would amount to an average 6.6% fare boost although the increase would be substantially higher for most smaller trunklines because of the $1 surcharge on the normally large volume of tickets sold over short-haul routes.

Interim Measure

The fare increase would be an interim measure only, effective until the completion of the General Passenger Fare Investigation. Undoubtedly, the Board will by-pass the statutory 30-day filing requirement and accept short-notice filing requests.

In such an event, the Air Traffic Conference of America, an organization through which all tariff revisions are filed, is keyed to distribute the fare changes through the use of conversion tables within 24 hours of Board approval of the fare if all airlines file for the increase. Should one carrier or more fail to file for the Board formula or file for a different rate, the conference would be required to revise all tariff manuals, a procedure requiring three to four weeks.

In arriving at the fare formula, the CAB was split 3-1-1. Chairman James Durfee and members Harmar Denny and Louis Hector voted for the 4% plus $1 increase.

Vice Chairman Chan Gurney asked for a 10% plus $1 increase and Member Joseph Minetti wanted no increase at all at this time.

Gurney was the lone dissenter in the Suspended Passenger Fare Investigation (AW Oct. 7, p. 38) when the Board refused to grant a request by seven airlines for a 6% increase. At that time, Gurney warned that the denial of the "small" fare increase places the airlines in a "critical financial position."

As late as November, the Board again turned down the 6% proposal by refusing to reconsider its earlier decision against such a move. The Board gave no reason for the sudden reversal of its 1957 stand.

Eastern Airlines was one of the first carriers to indicate it plans to file for the increase. The carrier also filed a plan to expedite a final decision in the General Passenger Fare Investigation. In effect, Eastern's action is similar to the proposal filed by American Airlines last month (AW Jan. 27, p. 38) except that it would limit the time for briefs to 30 days instead of 60 as suggested by American.

Airlines' Stand

Trans World Airlines emphasized the inadequacy of the adjusted rates by pointing out that the revisions would add only $2.80 to the New York-Chicago first-class fare.

In announcing his intention to file for the rate change, TWA board chairman and acting president, Warren Lee Pierson said:

"Conditions at that time (Suspended Passenger Fare Investigation) warranted at least a 6% increase, and the general financial condition of the industry has declined substantially since then."

United Air Lines, which has been asking for a permanent 17% increase, expressed disappointment over the Board proposal but by late last week decided to ask for the 6.6% increase. American remained quiet and there was strong indications that the carrier would not relent in its insistence for a 15% interim fare hike.

In its filing for the fare increase, Capital Airlines told the Board it was withdrawing its request for subsidy mail payments. It explained that forecast losses will not be as great as those anticipated in the petition for subsidy because of an improvement in current operating results. In a letter to Board Chairman Durfee, Capital's President David H. Baker said:

"What appeared on Nov. 6, 1957, (date of the subsidy filing) to be a serious and immediate financial problem for Capital now appears to be a serious and immediate financial problem for the entire domestic trunkline industry. Operating statements filed with the Board recently indicate that, with one exception, all domestic carriers operated at a loss in final months of 1957 . . ."

Commenting on the CAB's decision to grant the interim increase Air Transport Assn. President Stuart G. Tipton, accused the Board of evading its responsibilities "by seeming to fulfill them." He said the Board action solves nothing but merely postpones financial needs for jet operations and added:

"It took a Sputnik to shock the lag out of our missile program. Will we have to wait for Aeroflot, the Soviet's airline, to overtake us before the government appreciates the need for a privately financed U.S. commercial jet fleet?"

Tipton estimated that, if the proposed increase were effective Feb. 1, gross revenues for 1958 would be $1.7 billion compared to a $1.4 billion in 1957.

He said that 1958's net profit for the industry would amount to approximately $44.8 million compared to $25 million in 1957.

"The inadequacy of this amount comes clear," he said, "when you note that the combined profit for 1957 and 1958 will be about $66 million, or not much more than the $57.7 million registered in the single year of 1956.

The Air Transport Assn. estimated that the industry's 1957 net profit figure would have been $58 million instead of $25 million had the Board granted a 6% fare increase when it was first requested in March. It accused the CAB of gambling with the future of the airline industry and warned that, because of the current profit squeeze (AW Dec. 30, p. 29), "there is not enough money left over to adequately help finance the $2 billion jet expansion program."

Board Vote

The Board voted four-one–with Gurney again dissenting–to suspend the 15% fare increase filed by Continental Airlines and the petition by TWA for an overhaul of the fare structure (AW Jan 27, p. 38). Meanwhile, Capital lent strong support to the TWA plan which calls for basic per-mile first-class and coach rates.

Capital urged the Board to consider the fare equalization principle before a final decision is reached in the fare case and said the application of a basic rate "to the fare structure is long overdue."

Last fare adjustment was made in 1952 when $1.00 was added to existing one-way and round-trip rates. In 1948, a 10% increase was granted but the lower family rates and round-trip discounts were introduced at that time to offset the gain somewhat.

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has completed an official British Ministry of Supply type test in accordance with the combined U.S./U.K. test schedule at a rating of

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and is in production for the

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The British Air Registration Board have already confirmed that a civil version of the same engine has successfully completed a 150 hour test run in accordance with the combined U.S./U.K. Civil Type Test Schedule at a dry take-off rating of 16,500 lb. thrust.

ROLLS-ROYCE AERO ENGINES LEAD THE WORLD

Fatigue Signs Ground 21 Viscount 700s

London—Fatigue cracks in the inner section of the lower spar boom have grounded 21 of the first Viscount 700 turboprop airliners.

Cracks associated with bolt holes in the boom at certain undercarriage attachment points were caused by fretting of the skin on the boom in this region during landing.

Only 36 aircraft were prone to this condition as all subsequent production aircraft incorporated a redesigned deeper boom operating under lowered stress levels and fabricated from 24ST. This copper bearing material has superior fatigue characteristics to the 75ST alloy previously used. There was also a switch to steel bushed holes along the boom using fitted bolts and the insertion of a linen based plastic "Formapax" strip between the boom and skin. Bolts were wiped in mandatory chromated oil paint.

It was recognized that the fatigue life of the original boom was rather low. But on the strength of fatigue tests carried out on a cracked boom, these showed very low propagation rates: it was decided that replacement could proceed as part of a long term program. This program had been in operation for over a year and 10 aircraft had been modified up to date.

The grounding instruction from the Air Registration Board was based on the condition of a boom returned to Vickers last week. The cracking was much more pronounced and under test propagated fast enough to reach across the whole boom.

All the replacement booms are ready, having been prepared as part of the original program. Replacement time for each boom is about four weeks.

Withdrawal of the aircraft from service is not expected to have much effect on airline schedules owing to the slack winter service. British European Airways, which grounded 10 aircraft and Aer Lingus two, were both able to maintain schedules. Air France, however, with 10 aircraft grounded, was reduced to half its scheduled runs.

SHORTLINES

▶ **Air France** is conducting surveys for its new Polar route between Paris and Tokyo with an intermediate stop at Anchorage, Alaska. The new route is the result of a recent bilateral agreement between France and Japan authorizing the 7,324 nautical mile service. Lockheed 1649 Constellations are being used for the survey flights and will fly the route when service begins

Convair 880 Club Compartment Seats 12

First interior photos of full-scale mockup of Convair 880 turbojet transport show club compartment (above), passengers' folding tables (right) and two-abreast seating arrangement in four-across first-class configuration (below). Mockup is in San Diego, Calif. Club compartment is decorated with off-white shade on overhead sections; alternate stripes of turquoise, dark blue and white stripes on end partitions. Seats have black and white harlequin-patterned fabric. Compartment seats 12, takes up space equivalent to that occupied by 12 first-class seats. Airlines can change to five-across seating in 4 hr., Convair says. Color selections have not yet been made by customer airlines.

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ELECTRA PROP-JET TRAINER

America's first commercial prop-jet transport, the all-new Lockheed Electra, is now in production for leading world airlines.

Lockheed surveys of USAF training requirements formed the basis for Lockheed designs proposed for 2 trainer versions of the Electra. The advanced Electra navigator trainer and the electronic countermeasures trainer are both ideal for these highly specialized missions. Each combines new concepts of individualized student instruction, safety, performance flexibility and operational economy never before achieved in *one* airplane for Air Force training programs.

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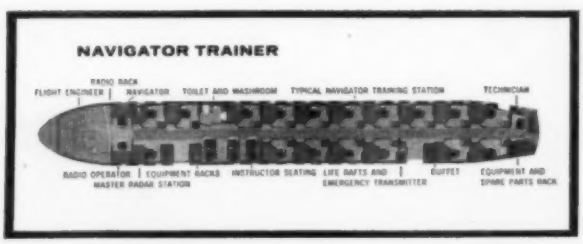
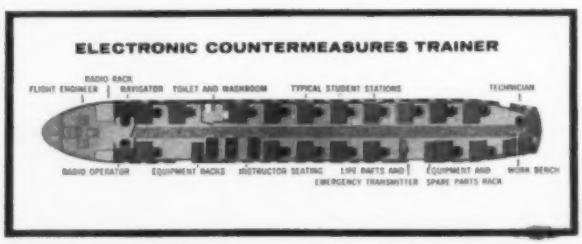




in April. Air France also has scheduled two special pilgrimages for the sick to Lourdes this year in cooperation with the Catholic Travel Office of Washington. The pilgrimages leave New York for Lourdes on April 23 and Sept. 27.

▶ **Air Transportation Assn.** reports U. S. scheduled airlines last year operated more intercity passenger-miles than the railroads for the first time. The association's figures—the first eight months actual, the last four estimated—show that the airlines accumulated over 25 billion passenger-miles, the railroads about 22 billion, excluding commutation.

▶ **British European Airways** reports a record net earning of $3,360,000 for the 1957 calendar year. With three months to go until the end of the current fiscal year, Lord Douglas of Kirtleside, BEA board chairman, predicts a net profit of nearly $3 million.

▶ **Braniff Airways** will begin service from the Southwest to Havana, Panama and other Latin American centers on Feb. 6, with Douglas DC-6 flights from Dallas to Houston, Havana, Panama, Lima, Peru, and Buenos Aires. A secpnd service will depart Dallas on Wednesdays for Houston and Rio de Janeiro. The return flights will leave Buenos Aires on Sundays and Rio on Fridays.

▶ **Frontier Airlines** reports several company records for the year ending Dec. 31, 1957. The carrier says it carried 212,500 passengers a total of 57,621,000 passenger-miles, an increase of 11% over 1956. It transported over 742,000 ton-miles of air freight, 88,000 ton-miles of air express and 214,500 of mail, both air mail and first class mail, during 1957.

▶ **International Civil Aviation Organization** has admitted Tunisia as its 72nd member.

▶ **North Central Airlines** flew 680,930 revenue passengers 100,744,479 revenue passenger-miles during 1957, a gain over 1956 of 24% and 21% respectively. The carrier flew 364,478 ton-miles of air express, a 1% increase over 1956, and 191,862 ton-miles of air mail, an 18% gain.

▶ **Seattle-Tacoma International Airport** handled a record 1,408,488 passengers —both inbound and outbound—last year, a 10% increase over the 1956 total. Air mail for 1957 was up 10% to 20,721,216 lb., but slight decreases were registered in air freight, down 5%; air express, down 5%, and first-class mail, down 2%.

AIRLINE OBSERVER

▶ Watch for a move by Great Britain to open a direct commercial air route from England to Mexico. Britain's Board of Trade wants to expand tourist traffic between the two countries as part of a trade package that also involves the purchase of Mexican frozen natural gas, the sale of British oil equipment and aid to Mexico in the development of a merchant marine.

▶ **Airways Modernization Board is negotiating with Aircraft Armaments, Inc. for the development of an electronic air traffic control simulator to conduct tests on design characteristics for data processing and display systems now being developed by the board.**

▶ Braniff Airways will farm out its turbojet overhaul work, but the carrier plans to do its own maintenance on turboprop engines and propellers. High cost of establishing jet overhaul facilities is discouraging smaller trunklines from following the practice of overhauling their own engines. Braniff's overhaul functions will be taken over by Southwest Airmotive in Dallas.

▶ **Soviet Russia and the U. S. last week agreed "in principle" on direct air service between New York and Moscow (AW Dec. 9, p. 38). The agreement came as part of an exchange agreement designed to improve mutual understanding between the two countries.**

▶ Varig Airlines of Brazil will power its three Boeing 707 transports with Rolls-Royce Conway turbojet engines. Engine overhaul will be handled by Rolls-Royce at maintenance facilities now being established in Brazil by the manufacturer. Varig chose the Rolls-Royce Avon turbojet engines for its two Caravelle transports on order.

▶ **De Havilland has launched a sales campaign for its Comet jet transports in Argentina, Australia, New Zealand, South Africa and Lebanon. The company is offering the transport with an early 1960 delivery date.**

▶ American Airlines is selling at least 30 Convair 240s to Dundel, Inc., a firm specializing in the leasing of aircraft. Ten of the 30 transports were sold last year and another 10 will be delivered to Dundel in 1958. The firm has an option on an additional 10.

▶ **Civil Aeronautics Board's Great Lakes-Southeast Case opened last week with 45 applicants and intervenors, including 14 airlines, scheduled to testify.**

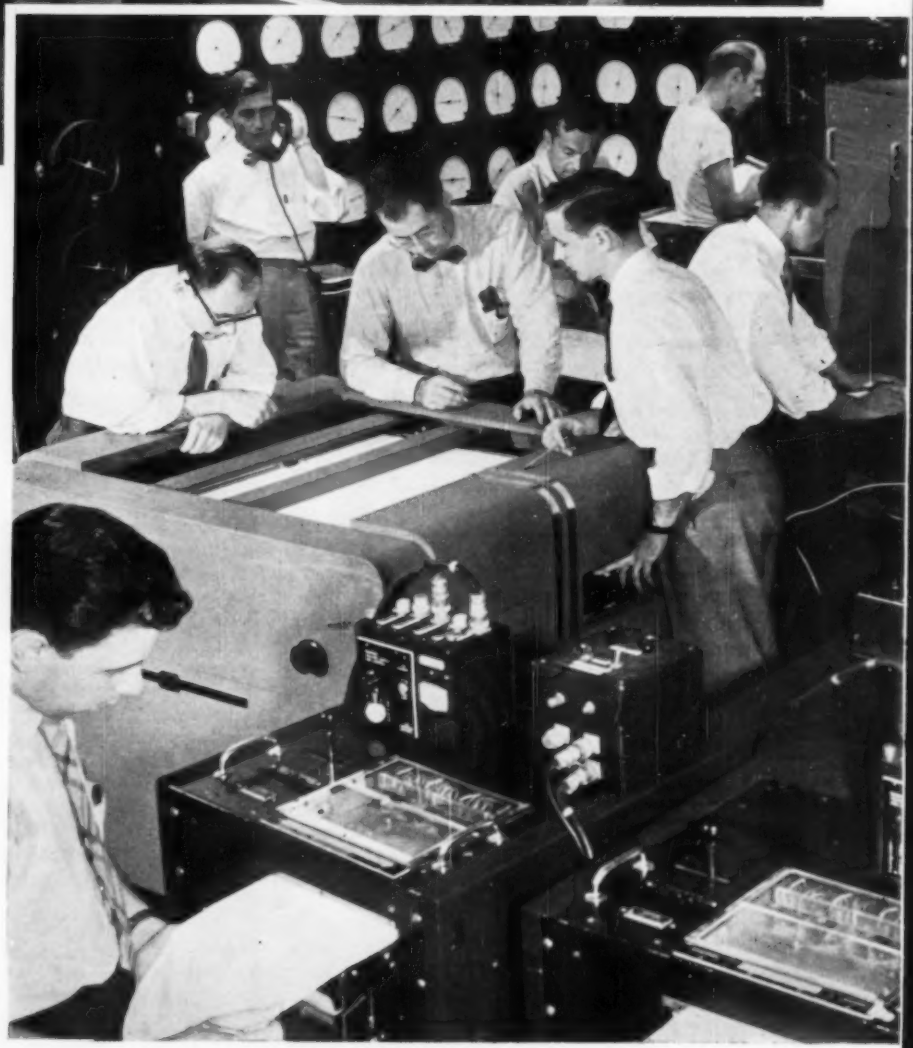
▶ Hawker-Bristol has a sales and engineering team in the U. S. discussing the firm's planned Bristol 200 with domestic airlines. The group will present to airline managements a detailed operating analysis showing performance of the aircraft on a wide variety of U. S. domestic routes.

▶ **Convair thus far has committed or spent $50 million on the development of its 880 turbojet transport, including more than $10 million in engineering costs. The company also has established an orientation program for airline personnel who do not require detailed technical knowledge but who must understand the broad aspects of the 880 program.**

▶ United Air Lines put four million man-hours into aircraft overhaul operations last year. The company overhauled 245 airframes during the year and 1,395 engines, including 11 engines for Japan Air Lines on a contract basis.

▶ **Nine member airlines of the newly formed Assn. of Local and Territorial Carriers met in a recent industry conference with all five members of the Civil Aeronautics Board to discuss local service problems, including an adjustment of the present mail pay system as a means of providing a greater incentive for more efficient operations. Joseph P. Adams, ALTA general counsel, acted as spokesman for the group.**

▶ Six scheduled airlines serving Denver plan a "hospitality day" for Air Force Academy cadets. For the second consecutive year, pilots and supervisory personnel of the airlines will invite cadets from the academy at Colorado Springs to spend Sunday in their homes.



MORE THAN HALF AN ACRE of computers in this laboratory provide answers at lightning speed for Pratt & Whitney Aircraft engineers. Included are four advanced IBM 704 machines. Each has some 30 satellite units.

COMPUTATION LAB

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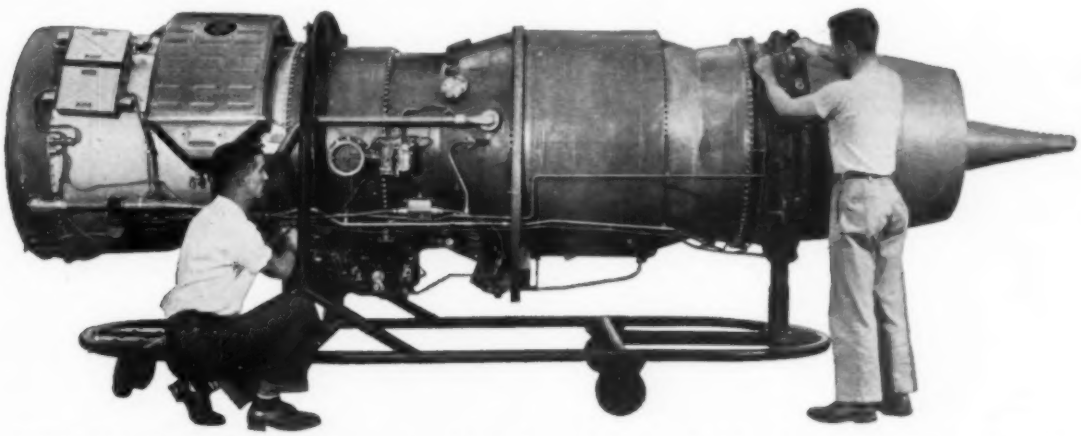
Engineers at Pratt & Whitney Aircraft have many matchless tools and facilities to call upon. One of them is the Computation Lab, the largest industrial installation of new electronic data processing equipment in the United States.

In an air-conditioned building at United Aircraft's Research Department, four giant IBM 704 computers, and other data processors, are now in full operation. They compress years of engineering effort into hours. Each 704, for example, is capable of performing about 2 million calculations a minute.

With these advanced calculators, it is possible accurately to predict performance of a complete engine through the whole range of operating conditions. Theoretical engines, too, can be tested mathematically, to provide knowledge practically unobtainable without computers. For more advanced problems, computers perhaps 100 times faster than the 704 are being developed.

Electronic computers had a major part in the design and development of Pratt & Whitney Aircraft's widely used J-57, and the J-75, most powerful jet engine in volume production. The electronic marvels of the Computation Lab, and many other advanced engineering facilities, will be even more important in future years in the design, development and production of the world's best aircraft power plants . . . in whatever form they take.



P&WA J-75, shown above, is the first engine to have guaranteed altitude operating performance. It owes much of its design superiority to the work of electronic computers.

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Weightlessness Crucial Spaceman Factor

By Russell Hawkes

Holloman AFB, N. M.—Effect on man of prolonged weightlessness is the remaining crucial unknown in manned space flight programs, and definition of crew roles must wait until it is better defined, according to Col. John P. Stapp (AW Jan. 13, p. 27), Commander of USAF's Aero Medical Field Laboratory here.

The Field Laboratory's research in human factors—notably Col. Stapp's own experiments with acceleration and the balloon flights under space equivalent conditions by Maj. David G. Simons and Capt. Joseph W. Kittinger, Jr.—has done much to build a foundation for projected manned space flights.

Col. Stapp credits Navy Capt. Albert R. Behnke with the classic work on long term survival in a totally hostile environment. Oddly enough, Behnke's study was aimed at solving the problem in nuclear-powered submarines. The U.S.S. Nautilus, first of the atomic subs, has remained submerged for more than two weeks and, says her commander, there is virtually no limit to endurance submerged.

Col. Stapp says there is no reason why men can't live as long in space as they can under water, if the absence of gravity can be ignored. Stapp says that past and current zero gravity studies are compromised by the difficulty of distinguishing between the effects of weightlessness and those of the violent entry maneuver. An hour of sustained weightlessness is needed to provide significant knowledge.

Unmanned rocket explorations and the Project Man High balloon flights of Kittinger and Maj. Simons (AW Aug. 26, p. 33) indicate that primary cosmic radiation is unlikely to prove injurious to human crews unless exposure is over a period of thousands of hours.

Col. Stapp told AVIATION WEEK that reliability standards needed to put space flight on a routine basis must be higher than those for current aircraft because survival is more precarious and there is little or no power of override enabling the crew to abort.

Three Objectives

Stapp said USAF space flight projects have three objectives. In order of priority, these are:

- **Proof that man** can tolerate all conditions of orbital flight including prolonged weightlessness. It is needed for completion of manned satellite and hypersonic glide vehicles which are already on the drawing boards. These should be potent nuclear weapon systems and reconnaissance platforms.
- **Development of a vehicle** for all types of interplanetary research. Military applications of research output consistently exceed the expectations of the researchers.
- **To price war** out of existence by making reconnaissance and weapons so effective as to necessitate the use or arbitration.

Stapp credited Russia's Sputnik flights with accelerating USAF's space researchers from money-starved, creeping evolution to a revolutionary pace. Details of the accelerated program have not yet been announced but Stapp assured AVIATION WEEK that belated grasp of the military potential in space flight by the public in this country will make good progress possible in the technology of human factors.

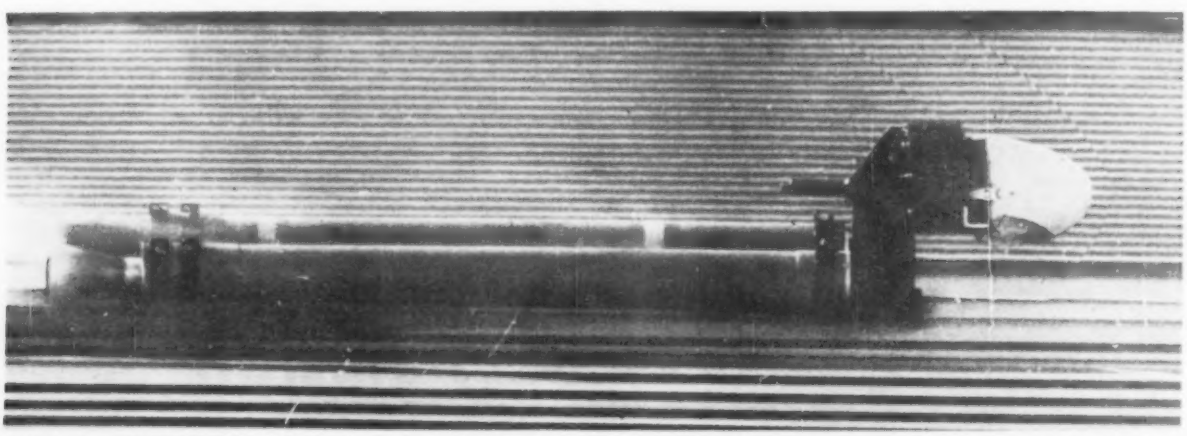
Stapp called the launching of Sputnik II an engineering accomplishment of the first order but said that as a biological experiment it could be regarded as only 35% successful since the dog was not recovered. He cautioned that we must expect similar failures in our first launches with animal subjects because of lack of experience in dealing with the problems of space flight.

He said that no manned space flight should be attempted until we have proved ourselves able to recover experimental animals alive consistently.

Crew Usefulness

Dr. Simons, as head of the Space Biology Branch of the Field Lab, is especially concerned with the problem of maximizing the usefulness of the crew of a satellite or space rocket. He told AVIATION WEEK that present measures of aptitude and performance are too crude for the purpose of determining the capability of scientists and crew members in space. He called the development of a more refined one a prerequisite to getting the most out of the crew, as their missions will demand nothing less.

Seeking a name for the new measure, Simons decided on "Creativity Index." He said it must describe creative imagination as well as initiative under specific circumstances and in quantitative terms. The Intelligence



USAF's Aero Medical Field Laboratory's Biodynamics Branch is studying effects of acceleration upon humans, as well as effects of weightlessness. Here, a shock wave forms over the top of a windblast helmet being tested at a speed of Mach 1.9. Stagnation temperature was 498F. The white enamel on the Fiberglas face protector used in the testing was scarred and eroded, but helmet remained intact.

Quotient and special aptitudes of space flyers undoubtedly must be high, but these measures tell nothing about the effect of circumstances on individual performance or the ability to seize an opportunity to change a research program or military mission profile on the strength of "on-the-spot" insight. The stresses upon the thinker will be high and possibly extreme if the unknown factor of weightlessness turns out to be important. Isolation limits the amount of help he can expect from Earth.

The Creativity Index would not be an unvarying measure of potential performance since its main purpose is to serve as a yardstick in determining variation in performance due to outside influences. In a qualitative and subjective way, Simons was able to notice changes in his own performance level during his 32 hr. aloft in Man High II which can be attributed to the unique environment of a telephone booth-sized capsule 100,000 ft. up.

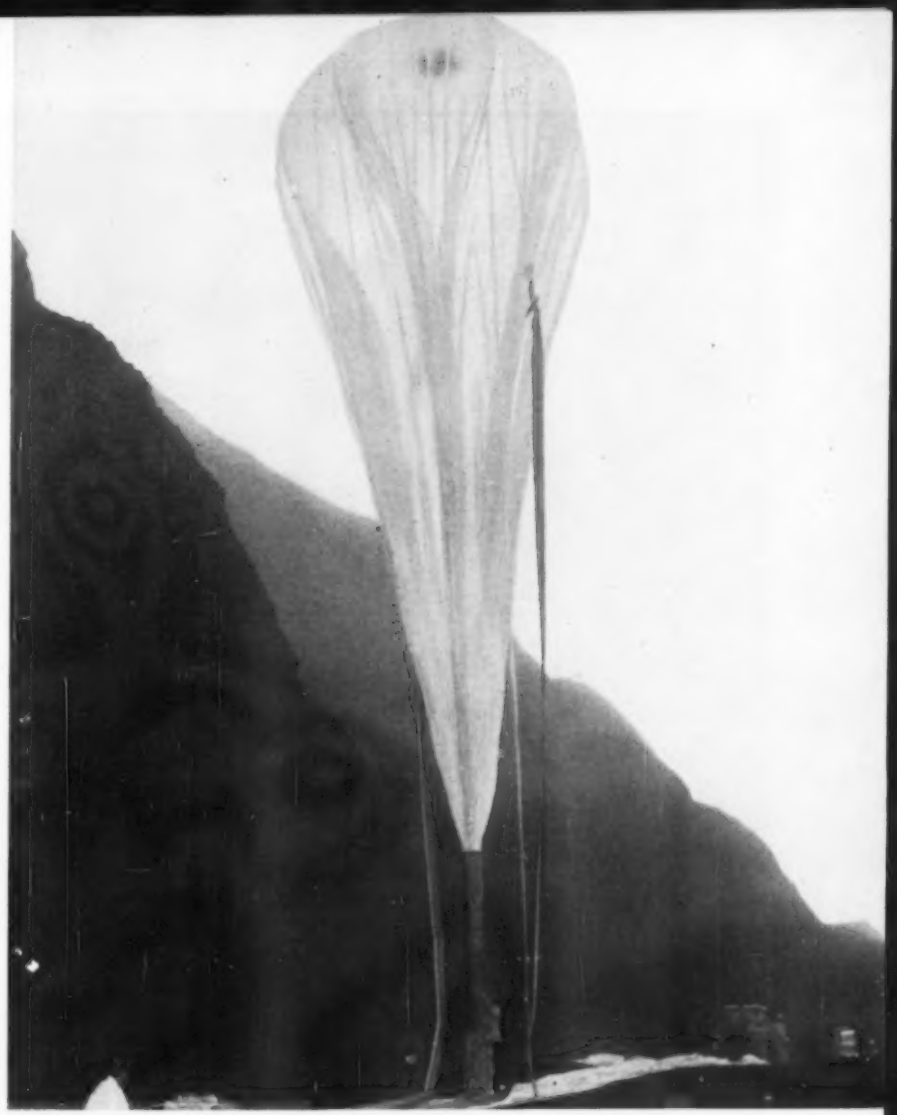
Creativity Index would provide a means of weighing the results of high altitude chamber runs and other laboratory tests to make them more representative of actual flight conditions. It would also be useful in designing equipment and plotting mission profiles so that the scientist or soldier will arrive at the critical point of the flight in condition to put out the best possible effort.

Space Flight Study

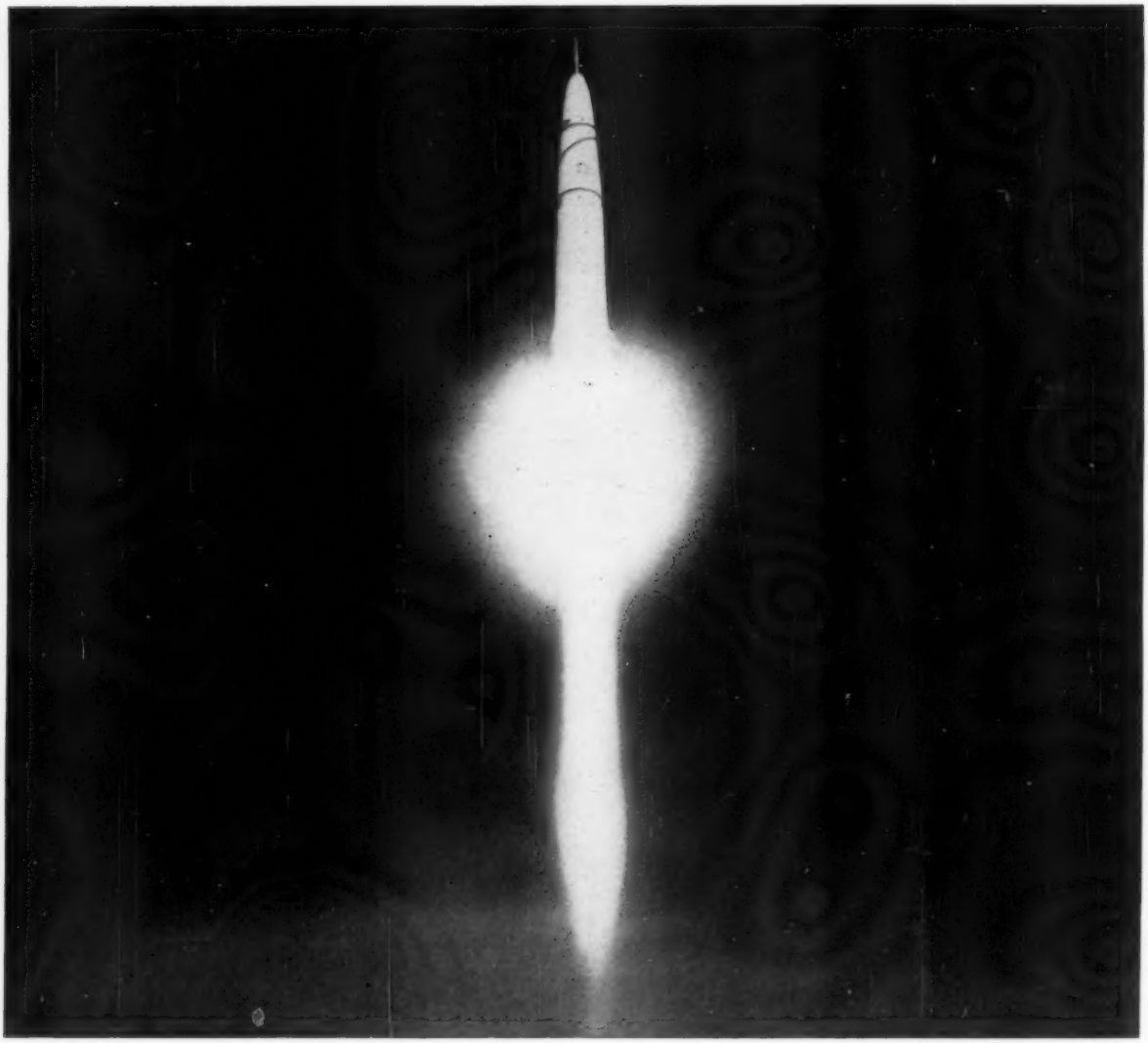
The Man High flights were conceived specifically as space flight study. Kittinger went to an altitude of 96,000 ft. in the first flight and Simons went to 102,000 ft. At that altitude, only 1% of the atmospheric mass remained between Simons and space.

The series of balloon flights is intended to check human reaction to all the tensions and stresses of space flight with the exception of weightlessness. These include stresses such as fatigue, extreme temperatures and discomfort and others stemming from the subject's knowledge that he is isolated in a completely hostile world and dependent on the machinery around him for his survival.

Most of these are new forms of old problems. Design of the closed circuit physiology system is based largely on Behnke's conclusions. The impossibility of pressurizing outside air to provide a survivable atmosphere in the capsule forced project scientists to devise a way of regenerating oxygen from stale air or create an open circuit system feeding the subjects stored oxygen and exhausting used air to the outside. Since less than 5% of the air inhaled is used by the body and the rest discarded, the volume stored in an open circuit system would have to be 20 times that needed in a closed circuit



MAN HIGH II balloon is inflated (above) prior to Maj. David G. Simons' 32-hr. flight. Conditions approximated space except for the presence of gravity. Patterns of light and clouds (below) as seen by Simons from 100,000 ft. could have value to meteorologists and geophysicists.



U. S. AIR FORCE PHOTOGRAPH

Thor guidance system keeps its bearings on New Departure Precision Ball Bearings!

The "AChiever"—inertial guidance system proved in recent flight tests of the Air Force's Thor long-range ballistic missile—delivers remarkably accurate performance.

Crushing acceleration . . . blast furnace heat . . . the near-absolute cold of outer space are missile flight conditions that test any guidance system to the limit. That is why the AChiever uses New Departure ultra-precise ball bearings.

The success of such a system depends on the most exacting accuracy in every part. Tolerances often must be measured in millionths of an inch, as is the case with the New Departure ball bearings on which the AChiever's precision gyros turn.

New Departure is proud to have measured up to the challenge, and is ready for volume production of some of the most precisely ground ball bearings yet produced . . . now in use in the guidance systems of guided missiles for the Army, Navy and Air Force.

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NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

system capable of reclaiming oxygen from exhaled air. To avoid a weight and size problem of this order, a regeneration technique was chosen with a basic atmosphere made up of equal parts of oxygen, helium and nitrogen. The carbon dioxide absorber in the air regeneration circuit is anhydrous lithium hydroxide. One pound of CO^2 can be absorbed by 1.35 lb. of LiOH.

Disadvantages are that it is a highly irritating dust that can make one cough uncontrollably for hours if inhaled and it draws moisture from the air in a reaction which releases heat. Quite a lot of LiOH dust passed the air filter at landing impact of Man High II. Fortunately, Simons had the presence

Regulus I Makes 18th Landing

Making its 18th roundtrip flight, a Regulus I passes landing controller (top) on its final approach. Officer in bottom photo gave countdown at launching site in control room beneath launching pad. The missile was launched from NAS Pt. Mugu and landed at San Nicolas Island.

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Wallace O. Leonard, Inc., *has recently developed a new design principle which insures exceptional performance in* **pneumatic regulators.** *The narrow tolerance on the regulated outlet pressure is achieved by an unique* **balanced metering valve.** *The* **sizes and weights** *of these new units show* **substantial reductions** *from those of conventional design. Test data, demonstrating the* **superiority** *of these new devices over previous regulators, is available.*

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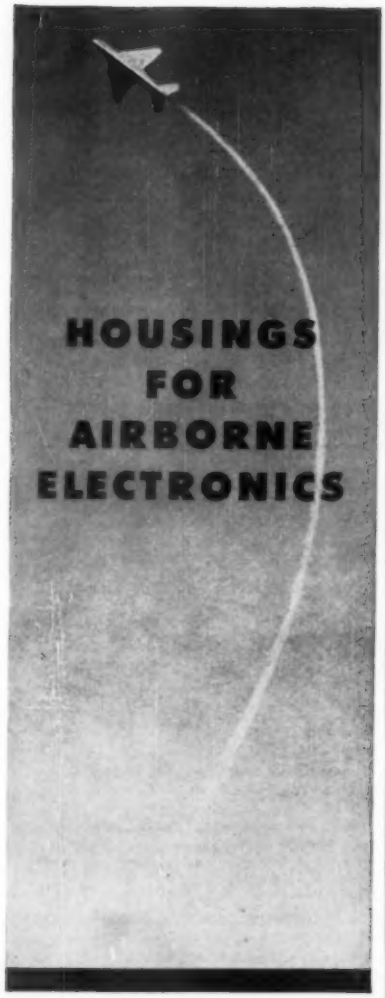

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Long a prime military contractor, Kaman is also a leading subcontractor to outstanding aircraft and missiles producers. Experience in processing and fabrication of magnesium and aluminum coupled with complete manufacturing and assembly facilities of over 500,000 square feet enable us to produce the most complicated housings and other assemblies for airborne electronic equipment to the most precise tolerances.

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of mind to observe this and hold his breath until he had escaped from the capsule. Water vapor is condensed out of the capsule atmosphere by the dry ice air cooling system during the day and absorbed by a two-stage chemical drying system using lithium chloride and magnesium perchlorate during the night when an air cooling system is not needed.

Crew Stresses

Since these systems are essential to life in space, they raise their own set of stresses upon the crew. They must always protect themselves against equipment failure because in many cases there is no reliable alternative. Man High II offered a reminder of this. Simons was reporting omni-range bearings in sets of three to give the command post tracking fixes and on the morning of the second day of flight, ground observers began to notice sizable errors. Capt. Erwin R. Archibald, physiologist in the Space Biology Branch, asked Simons to report his respiratory rate. This is controlled by the percentage of CO^2 breathed. Maj. Simons reported a rate of 44 and seemed to regard this as only slightly above the normal 12 to 18. Archibald was alarmed since in a trained medico like Simons it showed a lack of insight which might prevent him from saving his own life.

On advice from the ground, Simons checked the CO^2 concentration in the capsule and found it to be 4%. Behnke set 3% as the maximum acceptable level. Until the emergency was past, Simons spent alternate 10-min. periods breathing 100% oxygen in his pressure helmet and the CO^2 laden air of the capsule. Eventually, the air regeneration system began to function properly and the emergency procedure could be stopped.

Physicians acting as laboratory subjects have experienced high CO^2 concentrations before without losing the ability to evaluate symptoms. Simons has speculated that slow onset such as that which occurred over a six or eight hour period in the balloon and which might occur in space permits loss of insight to keep pace with the development of the more obvious symptoms. If this proves to be the case, the intelligence of the crew members will be no sure defense against failure of the air regeneration system in space.

Man High III

Man High III, the next balloon flight in the series, is tentatively planned for May or June. Further flights in the series are being considered and a two-man capsule is being designed by Winzen Research Inc. to increase the man-hours of research available in a flight.

Maj. Simons is emphatically against the idea breached in some quarters that the crew should be anesthetized during the launch and the initial part of the flight. He feels there is a role to be played by the crew in these operations and worthwhile observations to be made. The high level of mental efficiency Simons asks for is also apt to be impaired by the lingering effect of the anesthesia. Col. Stapp points out that going to sleep and awakening in

Students Practice at Missile School

Students at Army Ordnance Guided Missile School at Huntsville, Ala., practice teardown and reassembly of Nike-Ajax missiles in laboratory.

CASE HISTORY SERIES: Number ②

ENGINEERING REPORT

A Case History of Environmental Control

PROBLEM

VIBRATION • SHOCK AND COOLING

GUIDED MISSILE RELIABILITY

PROTECTION OF FUEL CONTROL EQUIPMENT from destructive vibration and shock in high temperature propulsion section of IRBM missiles.

SOLUTION

MODEL 1322 FOR REDSTONE AND JUPITER MISSILES
developed and produced in quantity for Redstone Arsenal and Chrysler Corporation.

ENGINEERED MOUNTING SYSTEM

MODEL 1322:

Robinson Model 1322 is a center-of-gravity all-metal mounting. Providing consistent performance regardless of high or low temperature extremes, this design incorporates highly damped Met-L-Flex resilient elements. All-attitude, multi-directional protection is assured.

SPECIAL FEATURES:

1. Ventilation screens at top and bottom of mounting enclosure allow the flow of cooling air, thereby extending the range of environmental protection.

2. Versatile mounting design facilitates adaptation to a wide range of components of varying dimensions.

PERFORMANCE:

Model 1322 protects against the rugged environment in the propulsion section of large rocket-type missiles. **Vibration, shock and acceleration forces** are controlled by the mounting system through a careful combination of spring rate and damping design characteristics. Natural frequency of model shown is 16 c.p.s. for an impressed excursion of .060 ins. and equipment weight of 8 lbs.

RESULT:

Adequate protection provided and reliability accomplished for vital elements of fuel control equipment through a light-weight standardized mounting system design. (Approximately six (6) systems installed in each Jupiter missile.)

ROBINSON CONTROL IS RELIABILITY CONTROL

ROBINSON
AVIATION, INC.
Teterboro, New Jersey
West Coast Engineering Office, Santa Monica, California

outer space would make a suitable plot for a nightmare. The difficulty of adapting to space flight would be compounded by sleeping through the transition from familiar to unfamiliar circumstances.

The Biodynamics Branch of the Field Lab is concerned mainly with the effects of mechanical forces upon living tissue. It is studying:

- **Patterns of deceleration** in space relative to human tolerances.
- **Effects on tissue** of changes in total pressure upon the body transmitted hydraulically through the blood vessels.
- **Human tolerance** to impact.
- **Tolerance** to wind blast.

Rocket Sled Track

Opening of the Air Force Missile Test Center's 35,000 ft. rocket sled track late next spring will provide the Biodynamics Branch with a valuable tool for investigating possible deceleration patterns. Variable water braking will make it possible to program quite complicated variations with some precision.

The Field Lab is expecting to make about two runs per month. When space vehicle design studies yield some deceleration curves, the lab will be able to simulate them.

This will pose interesting problems for the sled experts because the subject will be facing aft or in some other undesirable direction during the acceleration and it will be necessary to prevent the effects of this from confusing the data taken during the decelerative part of the run.

The total pressure experiments look beyond the pioneer space flights to a set of problems that are expected to be durable.

Pressure Fluctuations

These deal with pressure fluctuations in the canned atmosphere which can be caused by valve action or cycling in the air recirculation or by leakage. Wind blast during escape within the atmosphere also may do damage by increasing the total amount of pressure on body surfaces.

Field Laboratory scientists cite evidence the retinal hemorrhages suffered by Col. Stapp in his record speed run on the rocket sled and George Smith of North American Aviation in his supersonic ejection.

The experiments will be carried out in special pressure cell and the retina of the subject's eye will be photographed to measure deflection or failure of the retinal blood vessels. A large pistol pump will vary chamber pressure by as much as 10 atmospheres at a rate of 10 cps.

The cycling will probably last for only one to three seconds at first until some data has been collected on effects.

Scientists Simulate Re-Entry Conditions

Philadelphia—Using gas-stabilized arcs, scientists at General Electric Co.'s Missile and Ordnance Systems Department have succeeded in simulating the environment that will be encountered by an ICBM nose cone on its brief but critical re-entry into the atmosphere.

The new arcs are similar in operation to General Electric's original water-stabilized arc (AW Mar. 11, p. 31) but use gas instead of water as the source of the high-speed, high temperature plasma jet. Any gas can be used in the new arcs, but General Electric scientists to date have concentrated on dry air, helium, nitrogen and argon.

Designed specifically for use in General Electric's nose cone research, the arcs recreate re-entry parameters of heat transfer, temperature, pressure and environmental chemistry which correspond re-entry conditions.

The original water-stabilized arc, explain the scientists, fell down on the chemistry of the re-entry environment, limited as it was to its original molecular makeup of hydrogen and oxygen.

To get around this limitation, Gen-

Buckeye's

COMPLETE LINE OF REFUELING EQUIPMENT FOR . . .

OVERWING REFUELING

No. 9162 high capacity nozzle features easy opening, soft closing, minimum shock, during refueling operations. Also No. 8385 Non-Drip oil nozzle for delivering lube oil. Features sure shut-off, non-drip valve in end of tube.

No. 9162 Overwing Nozzle

UNDERWING REFUELING

No. 4092 valve is easily connected to aircraft fueling adapters. Makes a positive, leakproof connection. Basic mechanism designed to deliver 600 g.p.m. at pressure drop of 8 PSI through valve and adapter. Several different models available.

No. 4092 Underwing Nozzle

HYDRANT SYSTEMS

No. 13200 Emergency Shut-off valve can be remotely controlled. Adapter poppet valve and emergency shut-off valve work independently of each other.

Also No. 4096 series standard hydrant adapters; No. 4093 series hydrant coupling valves.

No. 13200 Hydrant Emergency Valve

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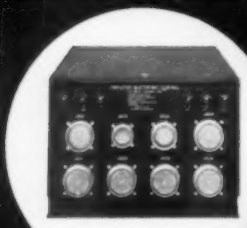
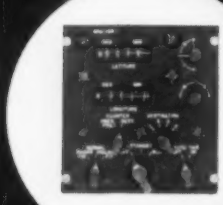
INERTIAL PLATFORM
Lightweight and compact, Kearfott four gimbal inertial platforms are characterized by rapid warm-up and alignment. Suitable for manned aircraft or missile applications.



COMPUTER-AMPLIFIER
For analog or digital data processing. Available with fully transistorized amplifier modules.



PANEL
Display and control panel for pilot reference or ground support equipment.

Other Kearfott systems feature 18 pound, all attitude platforms with 2 minute warm-up time. Examples of compass systems are conventional or roll stabilized directional gyros and all attitude platforms with 0.25°/hour maximum drift rates.

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Kearfott

GENERAL PRECISION EQUIPMENT CORPORATION GPE

eral Electric's scientists tried regular air, water enriched with nitrogen and water with oxygen added. Next, they were able to generate a plasma jet composed, in proper proportion, of atoms and ions of nitrogen and oxygen and molecular nitro-oxygen fragments.

In all, there are now six arcs in operation. There are, in addition to the original water-stabilized arc used for high temperature material testing, the following: A research arc, used to study the effects of a magnetic field on behavior and properties of a plasma jet; a reference arc which is a very pure arc and serves as a standard; an aerodynamic arc which simulates pressure distribution; a spectroscopic arc, used to study properties of materials and gases; and a supersonic arc which can simulate the chemistry of re-entry conditions.

For the future, General Electric scientists are working on the development of larger and more refined arcs, free from contamination and with improved flow, stability and temperature control characteristics. Too, there is no way at present to precisely measure temperature, pressure and material composition at the extreme conditions encountered in re-entry; and this is another problem the scientists soon hope to solve.

University Planning Materials Lectures

Pennsylvania State University is offering two short summer courses for engineers. Closely allied with today's emphasis on research and development, the courses are intended for design engineers and others engaged in research on materials. Lectures will be given by a number of prominent scientists and engineers.

First course, on Materials Engineering Design for High Temperature, will be held June 29 to July 3 at the Penn State campus.

Course will include metallurgical properties, mechanical static properties at high temperatures, thermal shock and fatigue properties and design for high temperature.

Course on Mechanical Properties of Materials will be conducted July 7 to 11, also at Penn State.

This course will cover hardness of metals, plastic behavior of metals under simple and combined stress, creep resistance and high temperature properties of metals, fatigue strength of metals, effects of radiation, developments in testing machines and instrumentation and metals under high speed loading.

Further information on either course may be obtained from Joseph Martin, Department of Engineering Mechanics, Pennsylvania State University, University Park, Pa.

Wind Tunnel Creates High Speeds, Heat

A wind tunnel designed to develop airspeeds of 15,000 mph. and temperatures of 18,000F is now under construction at Lockheed's Missile Systems Division, Palo Alto, Calif.

Known as a "hotshot" tunnel because of the extreme speeds and temperatures, it will be used to test nose cones for the Navy's fleet ballistic missile Polaris. It is expected to be ready for testing in early spring, making it the third tunnel of this type in the free world.

USAF Research and Development Command has two similar tunnels at its engineering center at Tullahoma, Tenn.

The tunnel is 44 ft. long, 6 ft. high and has a diameter of two feet.

Power for the air blast is generated by a 20 million kw. electric charge which explodes compressed air in a small arc chamber at one end of the tunnel.

The superheated air erupts through a diaphragm and rushes down the vacuum section containing the test missile creating heat and blast conditions similar to those encountered in the hypersonic flight regime.

The exploded gas requires only one-thousandth of a second to travel the length of the tube.

Firing time is limited to one twenty-fifth of a second to prevent the tunnel from melting under the 18,000F temperature.

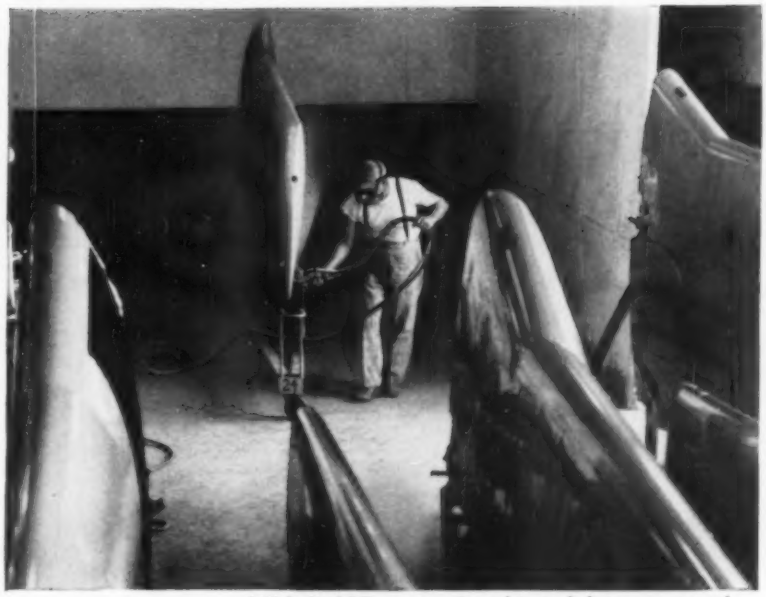
The electric arc, generated by 320 condenser units, creates pressure of 30,000 psi. to provide the motive force of superheated air.

Test missiles will be instrumented and high-speed electronic cameras will be used to photograph wind tunnel experiments.

Marquardt Revamps Air-Space Group

Marquardt Aircraft Co., Van Nuys, Calif., has named the company's air and space flight activities "ASTRO"—for Air-Space Travel Research Organization. John A. Drake will be director of the former long range planning and research division.

Research programs in the propulsion and accessories fields covering systems ranging from low-level atmospheric performance through space operations are being conducted. Particular emphasis will be given to combining optimum elements of various power systems to describe engines capable of propulsion from the surface of the Earth to outer space, President Roy E. Marquardt said.



A Binks Model 7 spray gun is used to apply hot-process enamel to wing sections for four-place Beechcraft Bonanzas. Location: Beechcraft Aircraft Corporation's Wichita, Kansas, plant.

Binks spray guns provide "wings" for finishing schedules

Fast application of mirror-smooth, tough-yet-flexible finishes to wing sections is a job tailor-made for Binks spray guns. Their excellent balance, regardless of spraying position, and almost effortless triggering action reduce operator fatigue and boost painting production. Fully adjustable needle valve compensates for wear, a common cause of faulty spray patterns, spoiled finishes and work stoppages.

A complete spray equipment line. Since man first began to take flying seriously, Binks has been producing an ever expanding line of spray finishing equipment to help add both beauty and durability to his machines. Today there are over 1100 standard spray finishing products, both manual and automatic, in the Binks line. Equally important is Binks nationwide service which puts you never more than a phone call away from on-the-spot repair and engineering help.

Engineering assistance available. Binks engineers know aircraft and the problems in finishing both component parts and finished assemblies. See for yourself how the combination of Binks equipment, service and "know-how" can help you get better quality finishing at less cost. Call your nearest Binks Branch office or, if you prefer, write direct to the address below.

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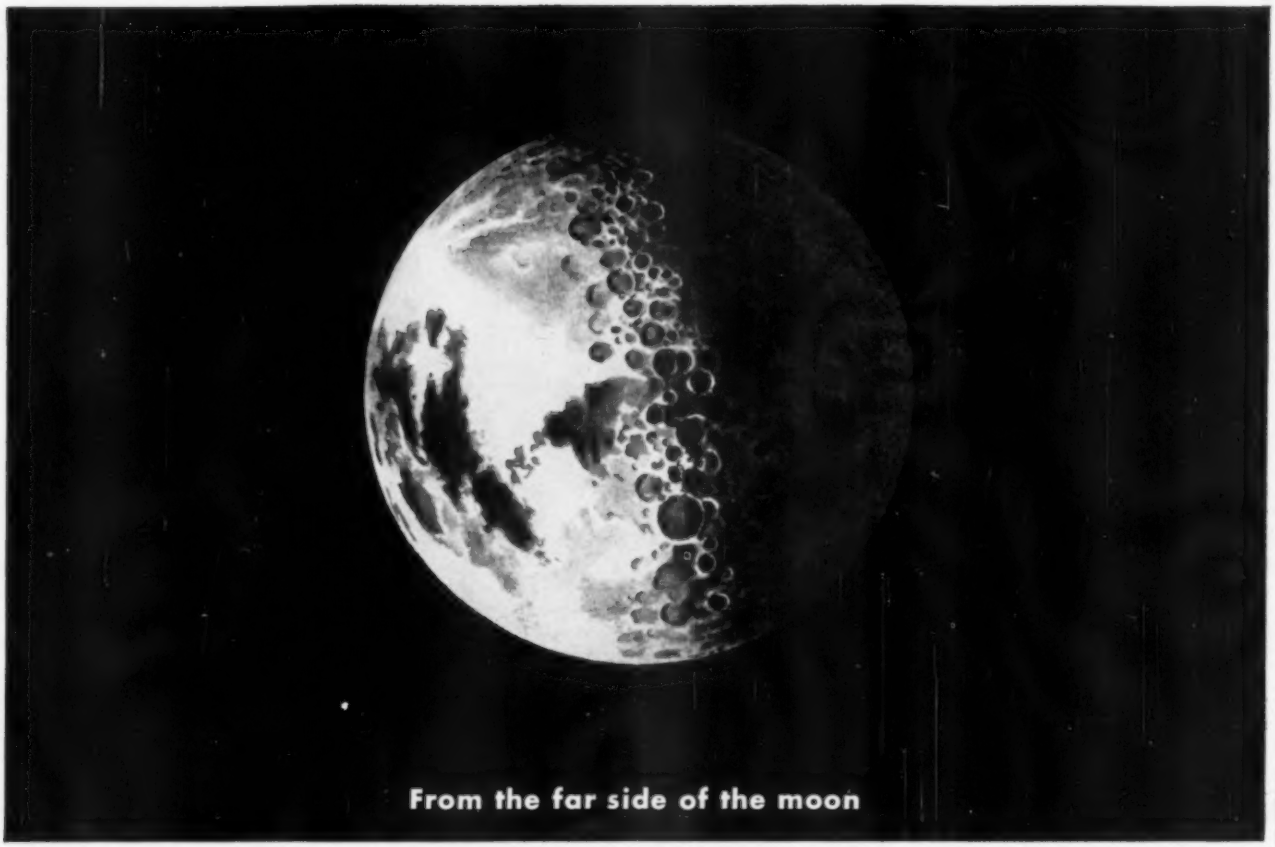
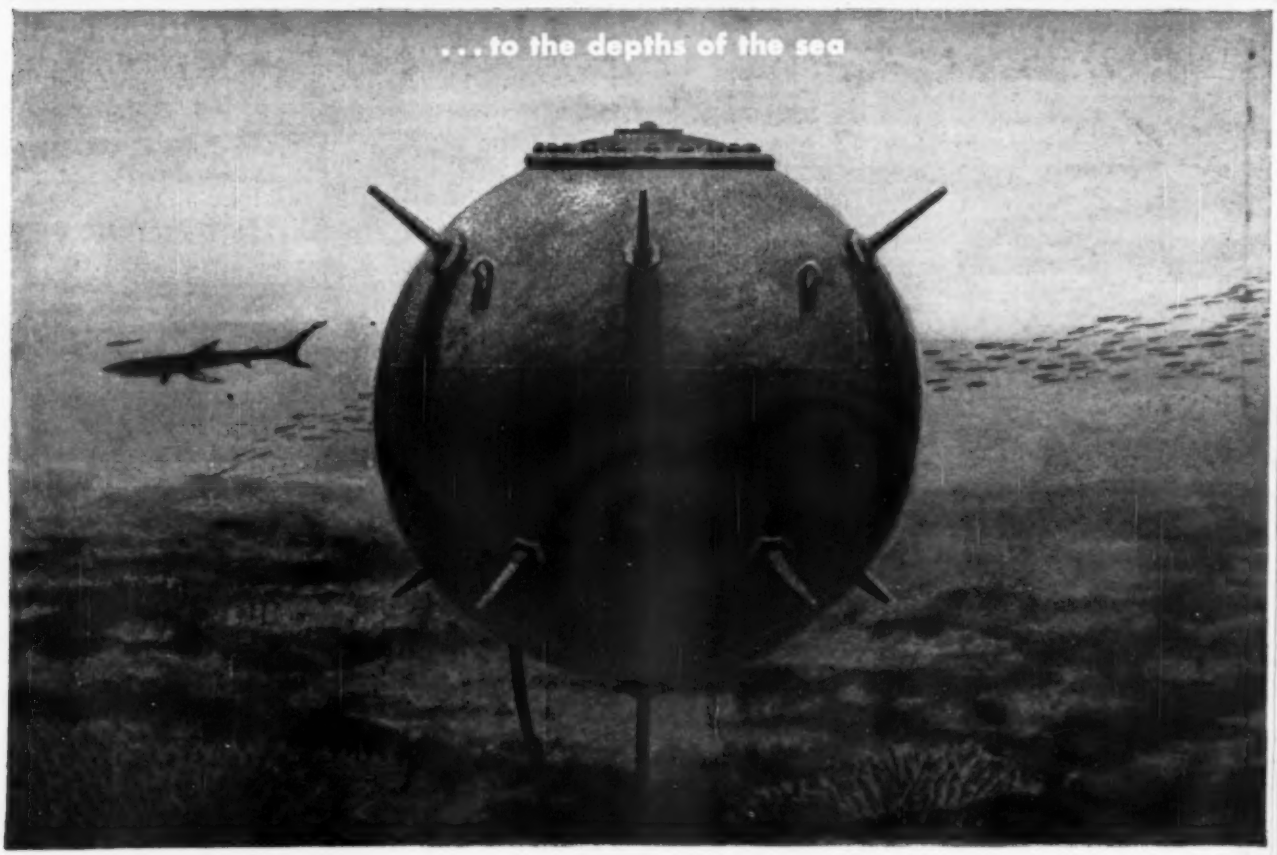


From the far side of the moon



. . . to the depths of the sea

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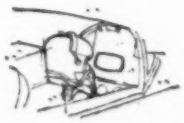
Honeywell puts 9,000 brain hours per hour to work on new weapons systems for our protection... you should know about them... *here they are:*

Inertial Guidance—Honeywell gyros, accelerometers and computers that send a missile home by "remembering" where it started, where it is, where it wants to go.



Engine, fuel and flight instrumentation—Honeywell designs easy-to-read individual instruments and integrated cockpit displays for high Mach aircraft.

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Flight Control—Honeywell leads in experience in developing and producing the complex systems for actual control of flight for high Mach aircraft and missiles

Test Instrumentation—Honeywell console test systems run complete check-outs on missiles before firing, saving time and money by finding failures before launching.

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Arming and Fuzing—Honeywell advances in infrared sensing devices and pressure sensitive systems allow precise detonation of high altitude missiles or underwater mines.

Navigation—Honeywell designs and builds inertial navigation systems for jet aircraft, blimps, surface vessels and submarines. There's no place where Honeywell *can't* go.

For information on the design of weapons systems or components for any type of missile, rocket or aircraft—call or write Minneapolis-Honeywell, Military Products Group, 2600 Ridgway Road, Minneapolis 13, Minnesota.

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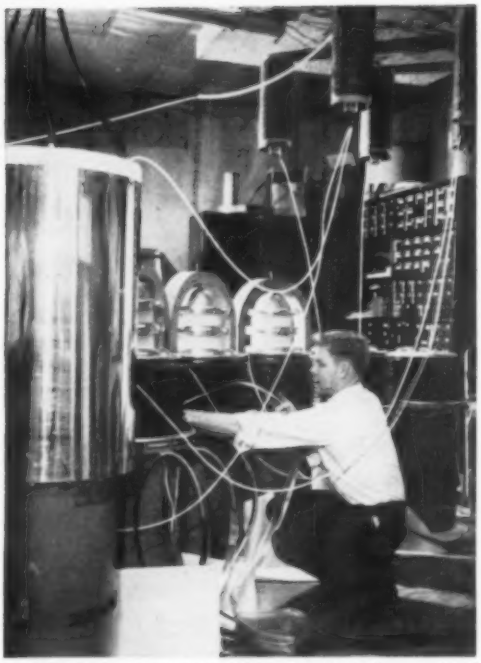
PERHAPSITRON, doughnut-shaped plasma tube used for controlled thermonuclear power research at Los Alamos Atomic Laboratory, has produced up to million neutrons per discharge for intervals of about two microseconds. Neutrons are an indication of thermonuclear fusion but can also be produced by other means and it is difficult to determine their source, Atomic Energy Commission has cautioned. Tests indicate an effective plasma temperature of about six million degrees Centigrade. This is small, but encouraging, fraction of the 100 to 400 million degrees estimated to be necessary for thermonuclear power generation.

U. S., British Scientists Stress Research in

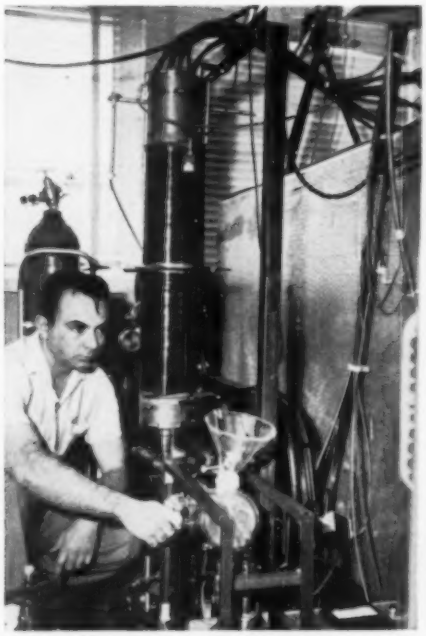
COLUMBUS II, another Los Alamos machine which uses a straight tube, has reportedly achieved three to five million degree temperature of its deuterium (heavy hydrogen) plasma and 10 to 100 million neutrons. Large capacitors around periphery shoot one-million ampere pulse through plasma, setting up magnetic field which pinches plasma, producing high temperature collisions and fusion.

GLASS doughnut-shaped tube, filled with deuterium forms heart of Perhapsitron. Copper enclosure for tube is employed to develop one of several magnetic fields used to constrain hot plasma and prevent if from coming in contact with container walls with consequent loss of plasma temperature, loss of active neutrons, and creation of "false neutrons."

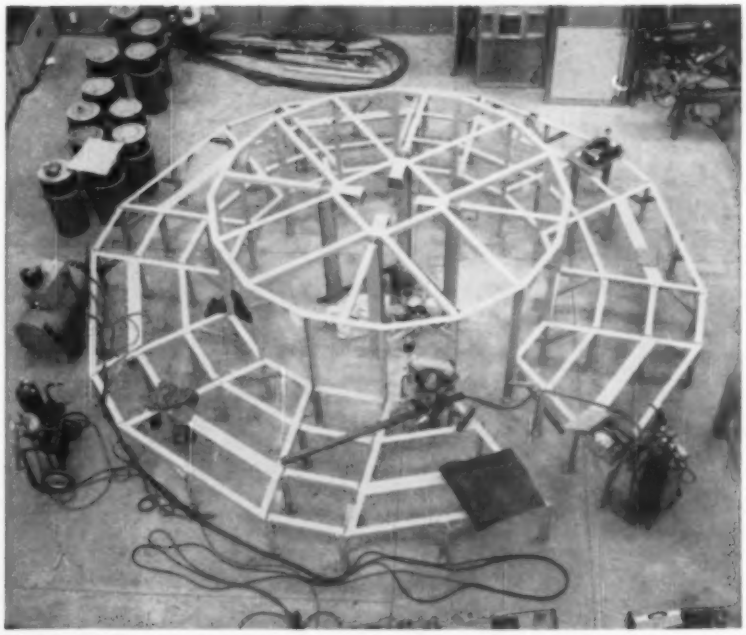


SPLIT-SECOND switching of hundreds of thousands of amperes current at thousands of volts is one of the biggest problems in producing controlled fusion power, Atomic Energy Commission says. Technique now used employs spark gaps whose firing times can be accurately controlled. Controlled spark research room is shown above.

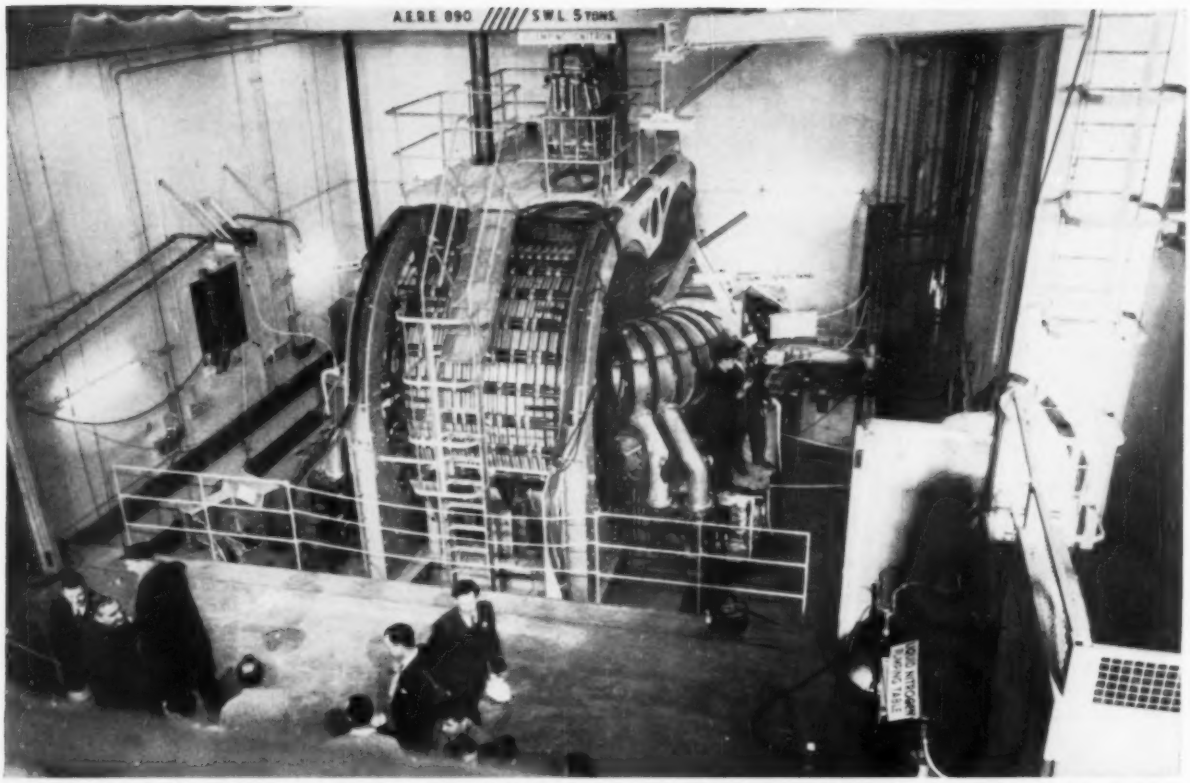
Thermonuclear Power Tests



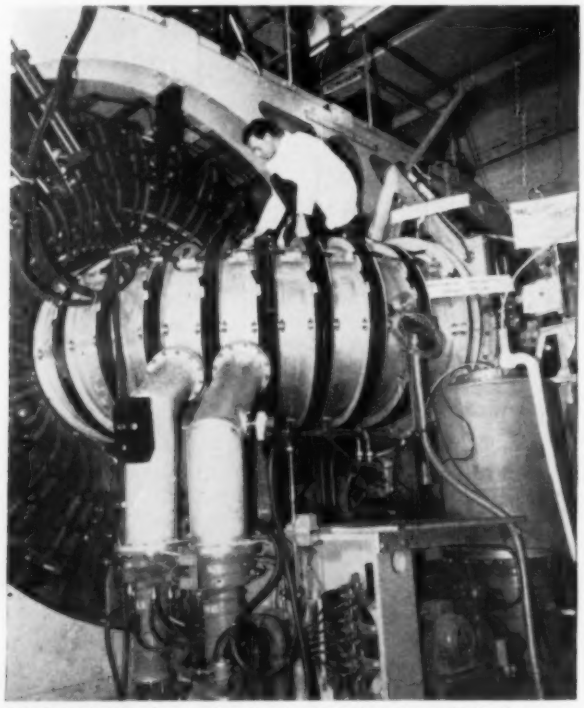
COLUMBUS S-4 plasma tube (center) is larger than one used in Columbus II, has produced lower temperature (3 million deg.) and fewer neutrons (10,000), but has shown that field produced by plasma current is highly reproducible. Particle energies of 300 electron-volts have been achieved with voltage under 20 kv.



NEW MACHINE of undisclosed type now is under construction at Los Alamos. AEC says it is spending 30 times more for thermonuclear power research this year than in 1953 at Los Alamos, University of California Radiation Laboratory, Princeton's Forrestal Research Center, AEC's Oak Ridge National Laboratory and New York University's Institute of Mathematical Science. Major General Bernard A. Schriever recently said thermonuclear rocket is farther away than others, but stressed pushing the program (AW Jan. 27, p. 35). Comparable British efforts are shown on p. 64.

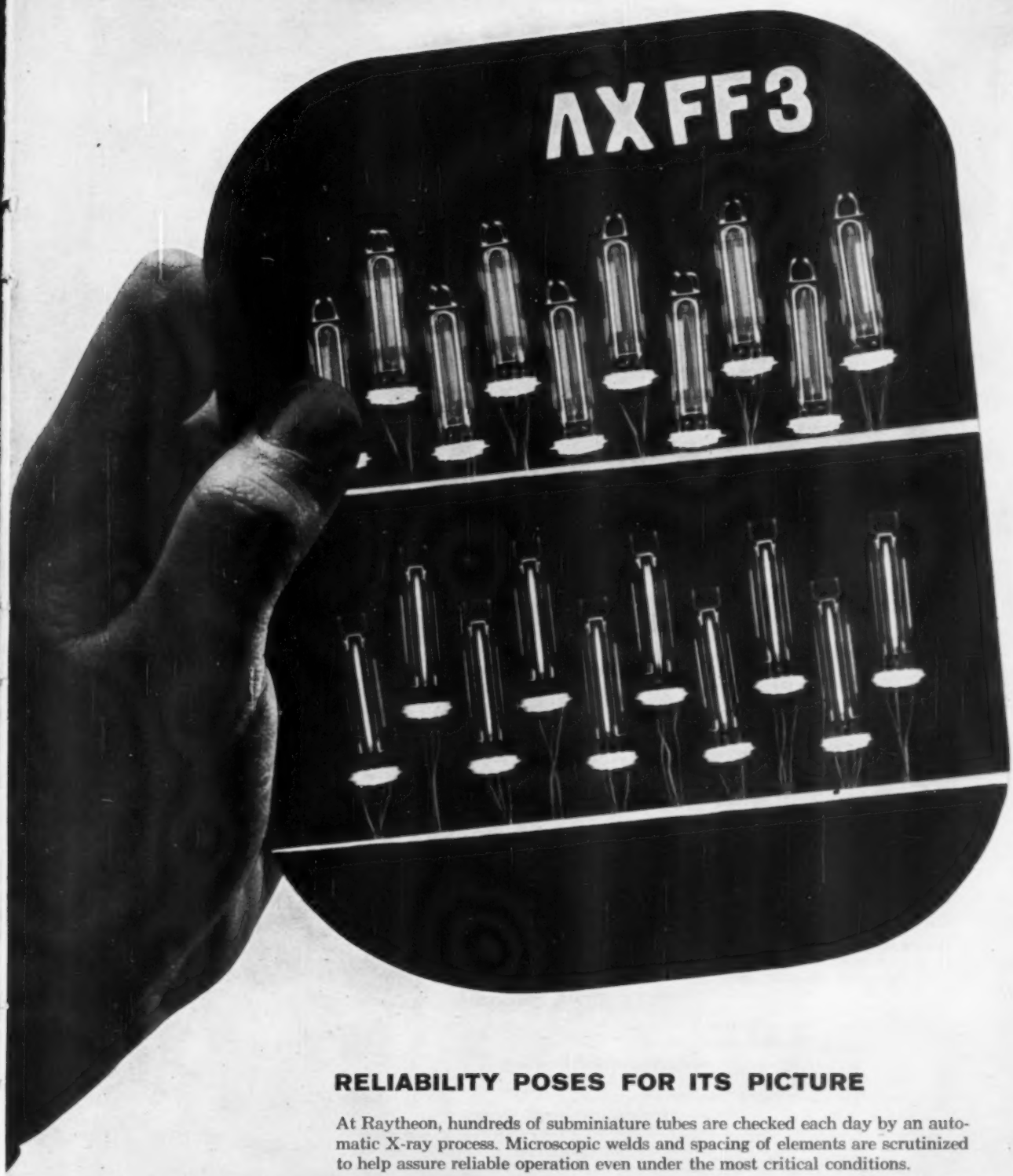


BRITAIN'S ZETA (Zero Energy Thermonuclear Assembly), at Harwell Atomic Energy Research Establishment, has achieved temperatures of 2 to 5 million degrees and kept hot plasma isolated from container walls for extended period of 2 to 5 milliseconds. British are optimistic that plasma isolation times can be increased. Question of whether neutrons are produced by thermonuclear reactions has not yet been definitely established but correlation between plasma current and neutron production suggests fusion.



RING-SHAPED plasma chamber for ZETA is about 10 ft. dia., uses 3 ft. diameter tube—far larger than U. S. machines. Pulse currents of 200,000 amp. have produced up to 3 million neutrons.

WORKING model shows primary winding of transformer (below) which induces high-current pulse in gas-filled glass tube whose plasma forms short-circuited secondary winding.



RELIABILITY POSES FOR ITS PICTURE

At Raytheon, hundreds of subminiature tubes are checked each day by an automatic X-ray process. Microscopic welds and spacing of elements are scrutinized to help assure reliable operation even under the most critical conditions.

This is only one example of the rigorous inspection and testing techniques that have earned for Raytheon components and systems a reputation for the utmost in reliability.

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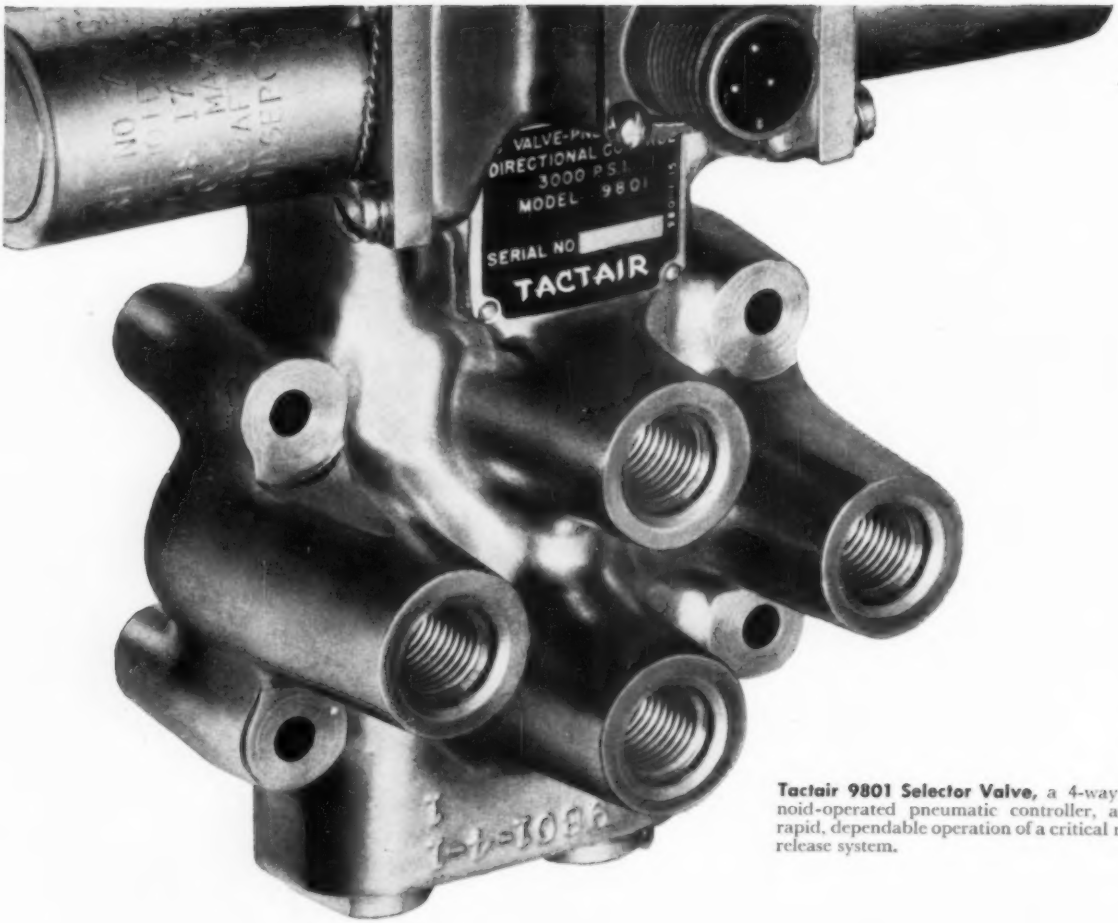

Tactair 9801 Selector Valve, a 4-way solenoid-operated pneumatic controller, assures rapid, dependable operation of a critical rocket release system.

Memo: to missile men looking for dependable components

Split-second operation, high flow capacity and low leakage are important requirements for pneumatic and hydraulic valves used in rocket and missile control systems. In addition, these components must be compact and light weight and provide utmost dependability.

Case in point: this 4-way, solenoid-operated, pneumatic selector valve for a rocket release mechanism. To assure its rapid, dependable operation over a wide range of operating pressures, we combined a number of tried and proved design principles used individually in other models. And to minimize weight, we made the valve a pilot-operated unit.

Result: an uncommonly wide pressure range of 500 to 3,000 psi at altitudes from sea level to 70,000 feet. Extremely high flow capacity for a valve this size—actual flow factor of .2 Qu. Low leakage—3 cc per min. of free air. Rapid operation—.05 sec. max. (energized). And with this, a weight of only 1.9 lbs.

Reminder: on standard or special components, we welcome the opportunity to assist you with your next precision valve problem. Every job we do is done on a personalized basis. It has been that way for 16 years. Tactair Valve Division, Aircraft Products Company, Bridgeport, Pa. BRoadway 5-1000.

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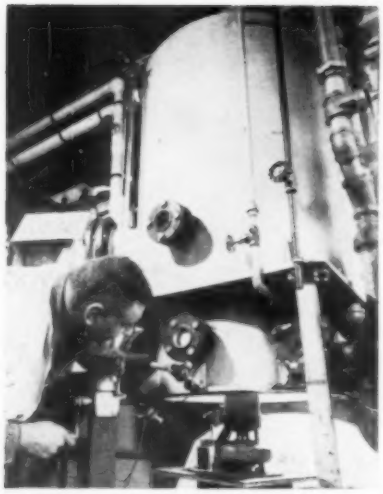

ENGINEER raises aircraft fuel pump motor into Westinghouse test tank.

Fuel Pump Motors Submerged for Test

At its aircraft equipment department in Lima, Ohio, Westinghouse Electric Corp. has set up a test facility to evaluate the performance of aircraft fuel pump motors while submerged in high octane fuel.

Heart of the facility is the two-chamber test tanks. During a test, the fuel pump motor is mounted in the top chamber which is then flooded with 165 gal. of high octane fuel. The bottom chamber remains dry. An access hatch in the lower chamber enables engineers to make the necessary power and thermocouple connections to the face of the pump motor.

Coils in the top chamber can heat or cool the fuel as required, and both chambers can be evacuated to pressures corresponding to an altitude of 65,000 ft.

The high octane fuel in the upper chamber is circulated by a pump at rates up to 200 gpm., while valves in the piping control the load on the test motor.

Canadair CL-44 Uses Turbine Power Unit

Auxiliary power units for the Canadair CL-44 transport will be supplied by the Engine Division of Blackburn and General Aircraft Ltd., of England, the British firm said recently.

Order is for Artouste 510 gas turbine engines which provide shaft horse power in addition to compressed air bleed, the former driving an alternator and the latter being employed for starting the main engines and air conditioning.

Unit can be installed in a self-contained power pod 74 in. long by 24 in. in dia.

Turbine has a single-stage, single-sided centrifugal compressor and an annular combustion chamber. There is a two-stage axial flow turbine, and the direct drive is taken off via helical spur reduction gears. Unit develops 80 shp. while supplying compressed air at the rate of 125 lb. per min. at a pressure ratio of 3.7:1.

Boeing's 707-720 Is for Medium Hauls

Seattle—Working from the basic 707-120 jet Stratoliner, Boeing Airplane Co. has modified structures according to a lower gross weight and shorter range operating envelope and combined the modifications with improved performance (12,000 lb. dry static thrust) and lighter weight of JT3C-7 Pratt & Whitney Aircraft turbojets to produce its 720 medium range jet transport.

Airplane has same dimensions as basic 707-120 with the shorter fuselage (128.8 ft.) of the two offered in the 707-120 series. Wing area, 2,433 sq. ft., is the same for both planes.

Wing and fuselage structural weight has been shaved with the reduction in fuel weight, so that highest maximum gross takeoff weight with the 720 is

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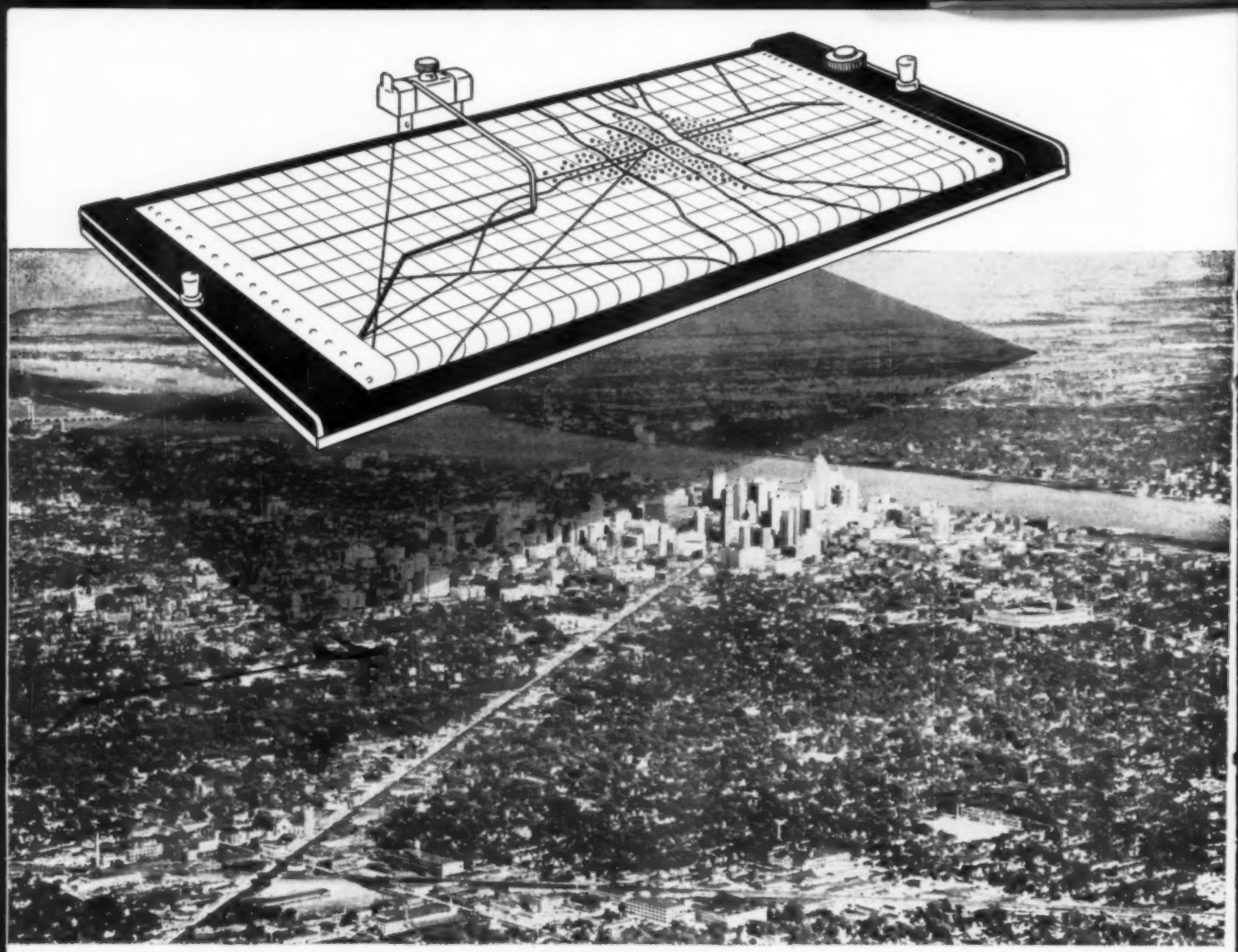

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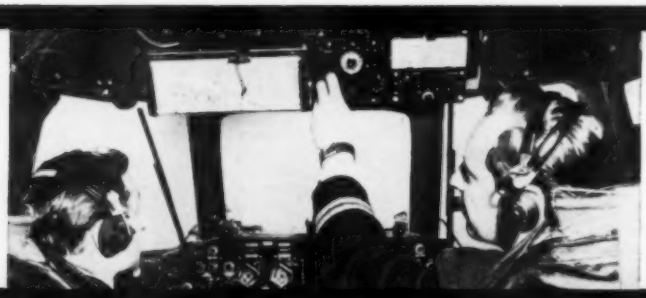
BENDIX-DECCA IS VISUAL. . . . The exclusive Bendix-Decca Flight Plotter continuously shows the aircraft position on an automatic chart—with pinpoint precision. This visual display in the cockpit—which can be duplicated on the ground—provides accurate aircraft location and track for efficient air traffic control over an area or along airways and especially at terminals.

BENDIX-DECCA IS THE HYPERBOLIC, LOW FREQUENCY, ALL-WEATHER SYSTEM. . . . Each chain covers an area of approximately 250,000 square miles from ground level to all altitudes. Shadows or reflections do not interfere with the accuracy of the system.

BENDIX-DECCA IS READY FOR IMMEDIATE INSTALLATION. . . . New chains have been installed by Bendix® within the past six months and additional coverage can be provided at once.

Originally developed in California, this navigation system is the most thoroughly proven in the world today.



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F-100D Picks Up Target

Target pickup is made as North American F-100D fighter hooks tow cable of Dart high-speed gunnery target. Hook device enables Air Force to use supersonic aircraft for target towing. The boom, developed by North American Aviation, is 10 ft. long and is made of 2 in. diameter chrome molybdenum alloy steel. It is fastened to an inspection door on the underside of the aircraft about one-third of the way forward of the tail. Hook can be cycled in flight and is easily removed from aircraft.

202,000 lb. Normal takeoff gross weight is 185,000 lb.

Seating capacity ranges from 110 in first-class configuration to 149 for all-tourist interior.

Systems of the aircraft remain substantially the same as those of the 707-120 (AW Jan. 20, p. 48), except that large wing center section fuel tank has been eliminated, although it apparently can be incorporated, and this would make up the difference between the normal gross weight of 185,000 lb. and the maximum gross weight possible of 202,000 lb.

Flight controls, hydraulics, remain the same, while electrical system is built about three 30 kva. generators, air conditioning uses only two air cycle (bootstrap system) compressors.

Gains in weight and engine performance have lowered plane's landing and takeoff distances according to Civil Aeronautics Administration standards; at the normal gross weight it can operate within majority of airports served by any airline.

Equivalent improvement is still available in the 202,000 lb. gross weight configuration.

Landing gear is lighter than that of 707-120.

The 720 performance is billed as a top speed of more than 600 mph., maximum payload of 33,000 lb. over a 2,600 mi. range, and economic opera-

French to Seek Altitude Record

Paris—French Air Ministry shortly will attempt capture of world altitude record using a Sud-Aviation Trident 2 interceptor.

Decision was made after Trident 2 recently reportedly climbed about 72,182 ft. at the French Air Force Test Center at Istres. Present world altitude record of 70,300 ft. was set last August by English Electric Canberra.

Recent French altitude test was carried out with Trident 2-04, first Trident interceptor to be equipped with Turbomeca Gabizo turbojets. In addition to these wing-tip jets, the French interceptor is also powered by a two-chamber rocket unit installed in the tail. Later versions of the Trident will have the same mixed propulsion system but the Gabizos will have afterburners. Ten preproduction Tridents are on order.

Also, at Istres recently, a Dassault Etendard 4 fighter powered by a Snecma Atar Turbojet claimed a new speed record over a 620 mi. course. Etendard speed, which is being filed with Federation Aeronautique Internationale, hit about 634 mph. Record flight was made out of Istres test center. Previous record for 620 mi. course was set last September by a Russian jetliner Tu-104—603 mph.

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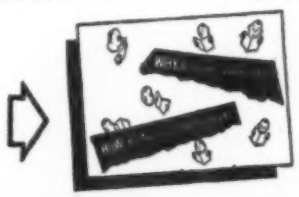

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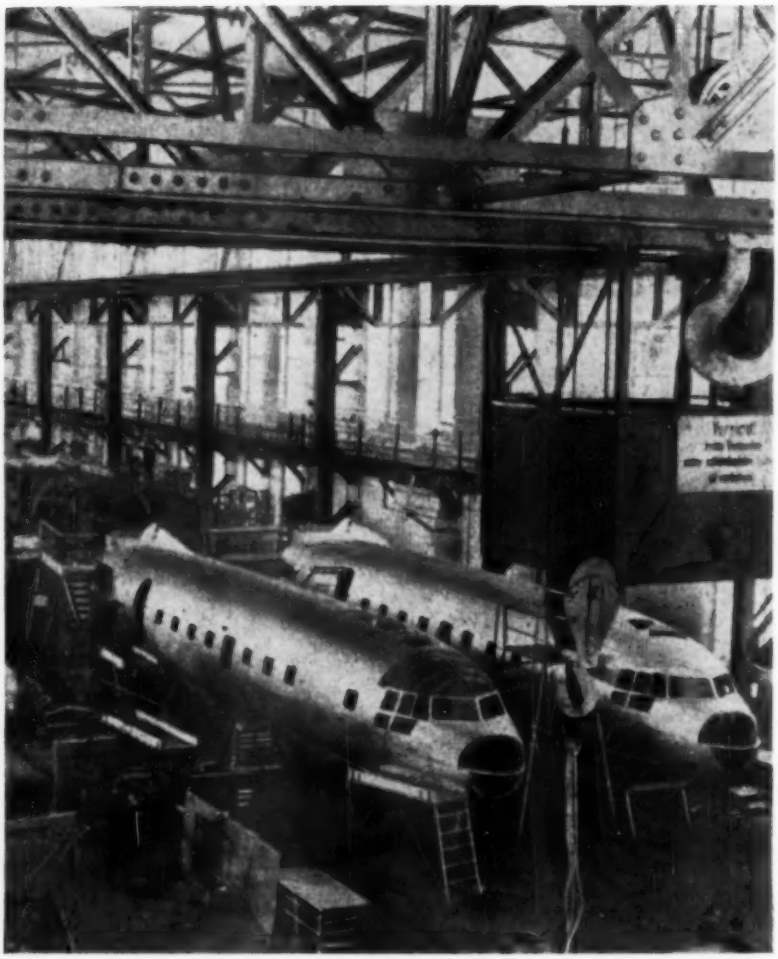


East Germans Build Soviet Il-14s

Two Ilyushin Il-14P piston transports being built under Soviet license in East Germany are shown at Industriewerk, Dresden-Klotsche, factory. Basic design carries crew of five and 18 passengers. Increase in payload has been obtained by using lightweight materials.

tions on ranges as short as 150 mi.

Boeing figures place the 720 break-even load at approximately 55 passengers, no cargo aboard on a 500 nautical mi. stage, with a first class space-limited airplane, at the normal gross weight of 185,000 lb. Air Transport Assn. formula on direct and indirect costs was used, giving a 6.75 cents revenue per passenger-nautical mile. Fuel reserve for 1¼ hr. holding was allowed.

Navy Signs Contract For KDA-4 Firebees

Navy has awarded Ryan Aeronautical Co. an $8 million contract for production of 600 mph. advanced model KDA-4 Firebee drone, the company said. Contract includes $1.75 million worth of spares and extends Firebee production into the latter part of 1959. The new order will be phased in with present production of KDA-1 Navy and Q-1A Air Force versions in final assembly at Ryan's new Torrance, Calif., plant. Parts are fabricated at the main plant in San Diego. Drone operates up to 50,000 ft., flight duration is over an hour.

Piasecki, Breguet Sign Exchange Agreement

Piasecki Aircraft Corp. and Ateliers d'Aviation Louis Breguet of Paris, France, will exchange technical information under an agreement signed by Frank Piasecki, president of the American firm, and Henri Ziegler, director general of the French company.

The agreement which is tentatively set for a 20 yr. duration, includes sharing specific aircraft designs, production techniques, and research, engineering and testing facilities. Contract also covers cross licensing of patents, manufac-

turing agreements, and reciprocal sales rights in the U. S. and Europe. Piasecki is reported to be interested in some Breguet STOL/VTOL designs. A version of the Breguet 941 STOL transport (AW June 17, p. 79) is known to be nearing flight test stage in France.

Agreement between the two companies is effective immediately, and Breguet engineers are now in the U. S. for technical conferences.

Lockheed, Machinists Sparring on Contract

Burbank—Lockheed Aircraft Corp.'s California Division and Lodge 727, International Assn. of Machinists, are in negotiation for a new contract to replace present one which expires March 5. Some 16,000 employes are represented by the bargaining units.

Lockheed management, in a statement issued by Burt Monesmith, Lockheed vice president and general manager of California Division, says union contract demands would total 80 cents per hour increase in wage hikes, fringe benefits, "besides other cost items involving additional sums which we cannot now even begin to estimate accurately.

"Magnitude of union demands is indicated by the fact that if they were granted in toto, they would increase California Division's payroll and fringe benefit costs by $50 million a year—or 35%."

Machinist Lodge President John Snider, who heads union's bargaining committee, says union is asking a 13 cents an hour pay increase to match cost-of-living increases granted in other plants having escalator clauses, which Lockheed contract does not have, plus a 6% blanket raise. Basic union demands, Snider says, will cost 27 to 28 cents an hour.

Union also is asking a 35-hr. work week for 40 hr. pay, which has been asked for several years; also seeks union shop, seniority basis for layoffs, recalls. Snider says presently senior personnel have no protection in contract for inefficiency, that if company discharges a man for inefficiency, it will stick. However, union says it also wants some protection for senior men earning senior wages in cases of force reduction.

North American to Sell Australians F-86 Parts

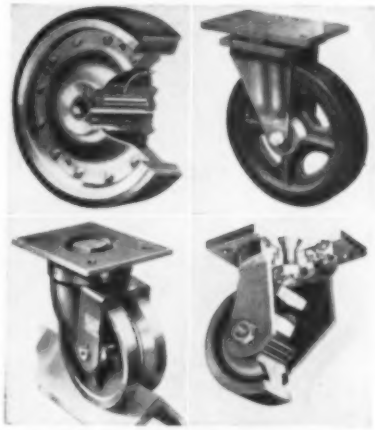
North American Aviation Los Angeles Division will supply Commonwealth Aircraft Corp. of Australia with $900,000 worth of F-86 parts.

Commonwealth Aircraft has a contract to build Avon turbojet powered Sabres for the Australian Department of Defense.

Helicopter Offloads Lightplane

Sikorsky HUS-1 general purpose helicopter lifts Cessna OE-1 observation aircraft from the flight deck of the U.S.S. Lake Champlain and prepares to carry it ashore. Operation was part of Marine Corps amphibious training exercises.

THERE'S NO SUBSTITUTE FOR DEPENDABILITY....



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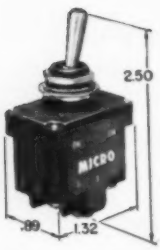
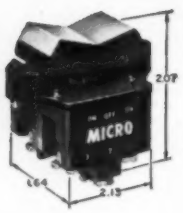


2TL1 Series



4TP1 Series

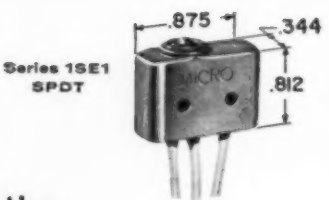
NEW!

Sealed, manually-operated switches for unusual reliability

MICRO SWITCH "TL" and "TP" Series switches are ideal for applications which call for unusual reliability and long-life performance. All are completely sealed. A silicone seal between the lever actuators keeps dust and moisture from the switching chamber. The switch case is sealed to the cover by a liquid sealant which cannot harden. Note the step design incorporates integral terminals for ease in wiring.

MICRO SWITCH "TP" switches are a completely new design. Rocker actuation makes switching easy, yet false or accidental actuation is reduced to a minimum. The "TL" Toggle Switches are for applications requiring dependable, long-lasting toggle operation. They are available in single-pole, double-pole and four-pole double-throw circuitry.

(Send for Data Sheet 139 and 141)



Series 1SE1
SPDT

Here are the smallest and lightest environment-free switches

MICRO SWITCH "SE" Series of subminiature switches combine small size with completely sealed construction and precise operation. They are the smallest and lightest of environment-free switches. They will give trouble-free operation in temperature ranges from —80°F to 230°F.

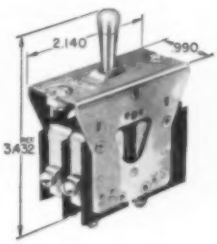
The switching unit is sealed with an elastomer plunger seal which is bonded to the pin plunger and the metal housing. The switch is embedded in an epoxy casting resin within the housing. Exterior of the housing is corrosion-resistant treated aluminum.

Basic "SE" switches are for in-line plunger operation. They may be used with auxiliary actuators for cam or slide operation.

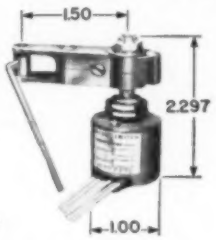
(Send for Catalog 77)

Switches have uses unlimited

Manufacturers of aircraft, aircraft components, missiles, launchers, and rockets invariably consider MICRO SWITCH first . . . MICRO SWITCH was the first to introduce miniature precision switches to the industry . . . For 20 years MICRO SWITCH quality has been steadily improved . . . MICRO SWITCH offers the most complete facilities for development, design, engineering, production, quality control and testing of small, lightweight precision switches. Field engineering offices blanket the country. There is always a MICRO SWITCH man near you—ready to cooperate on aircraft switching problems.



Series 41EN1 (MS24420-1) with rotary linkage actuator



These switches give reliable performance under all atmospheric conditions

MICRO SWITCH Series "EN" switches are completely sealed against the effects of changes in atmospheric or environmental conditions. The precision switching units are housed in an air-tight enclosure. The enclosure is evacuated and filled with an inert gas under pressure, insuring constant operating characteristics of the switching elements.

The actuator mechanism operates through a seal which prevents entry of dust, moisture or air into the switching chamber and assures maintained pressure of the inert gas. An ice scraper ring on the actuator shaft removes any ice or mud which might collect on the actuator, thus preventing plunger jamming or binding. These switches are available in a wide range of actuators, and mechanical and electrical characteristics.

(Send for Catalog 77)

Seven outstanding features make this an ideal switch for airborne applications

This "pull to unlock" 115AT Series Toggle Switch has a positive lock which holds the toggle lever in a "set" position. A definite pull (approx. .109 in.) must be made to change the lever position from one locked position to another. This insures against accidental movement of the toggle lever.

Outstanding advantages of this switch for aircraft applications include:

- **Compact design**
- **Positively driven switch actuating levers**
- **Strong, rigid construction**
- **Makes or breaks circuits in all three lever positions**
- **Positive lock lever guard**
- **Easy mounting**
- **Four SPDT circuits**

(Send for Data Sheet 134)

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IGY Data Adds to Earth, Space Theories

By James A. Fusca

Washington—New understanding of Earth and the space around it is emerging from data gathered during the first five months of the International Geophysical Year. Especially in studies of the upper atmosphere, these additions to man's knowledge of his environment suggest potential improvements in the aeronautical and avionic arts. They include:

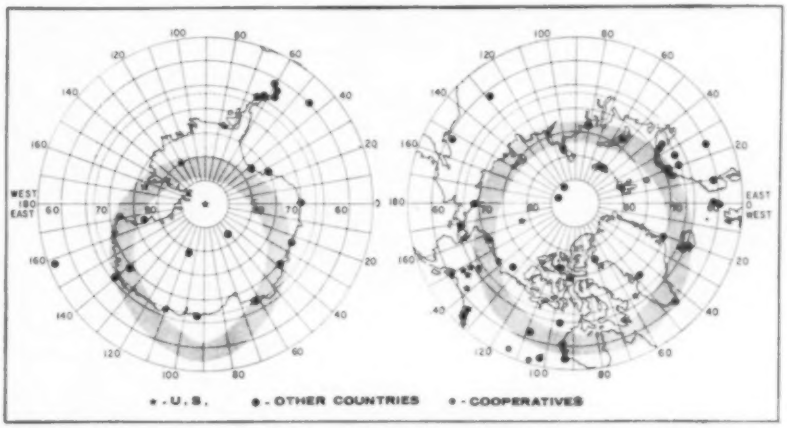
• **High altitude flight.** Earth's atmosphere apparently extends much higher than previously thought, implying an unsuspected heating problem for missiles, satellites and—eventually—manned space vehicles. Ionization trails generated by these objects potentially offer new methods of detection and communication.

• **Radio communications.** Increased knowledge about changes in the ionosphere can improve the reliability of radio communications by aiding predictions of propagation conditions and "radio blackouts."

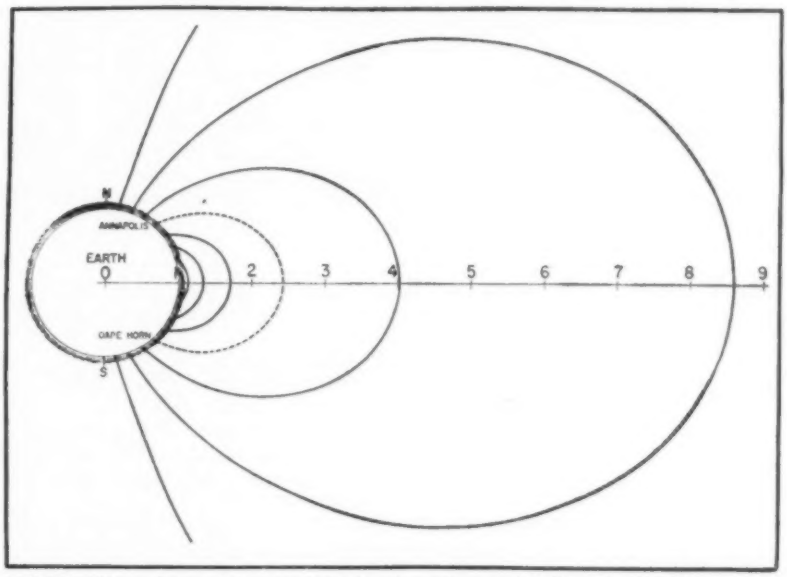
• **Whistlers.** Studies of whistlers—very low frequency radio noises generated by lightning strokes—show that they are reflected back and forth over paths extending several thousands of miles into space between physically related (conjugate) areas in north and south hemispheres, approximately following lines of the Earth's magnetic field. This mode of propagation may find uses in point-to-point communications.

• **New power sources.** Three great electric currents, with strengths that may reach several hundred thousand amperes, circle the Earth. Two of these currents circle the north and south magnetic poles while the third follows the Earth's geomagnetic equator at altitudes as low as 60 mi., offering a large potential source of power.

Report on participation of the U.S. National Committee for the International Geophysical Year has been made by Hugh Odishaw, its executive director, published in a recent issue of Science, a publication of the American Association for the Advancement of Science.



TWO of the three rivers of electric current flowing around the Earth through the ionosphere circle the north and south magnetic poles in the areas of maximum auroral frequency, shown as stippled bands. Third electric current circles the equator. IGY geomagnetic stations of U.S. and other participating countries are shown, as well as cooperative stations.



WHISTLERS are believed to penetrate the ionosphere and follow the Earth's magnetic field into the opposite hemisphere. Sketch shows Earth's dipole (idealized) magnetic field for each 10 deg. of geomagnetic latitude. Stippled zone is the known ionosphere. Scale units are equivalent to Earth radii; dashed line is the whistler path from Annapolis, Md., to Cape Horn.

Major Findings

No final theory or model capable of fully explaining the relationship between Earth's upper atmosphere and the Sun exists today, but the importance of the relationship is becoming increasingly apparent as more of the answers are found.

Theories that apparently are being confirmed as the IGY data is assembled picture the Earth's atmosphere as decreasing upwards in density until it merges with a tenuous interplanetary atmosphere that is part of the Sun's corona. At the distance of Earth's orbit from the Sun, the density of this solar atmosphere is about 1,000 particles per cc., mostly protons and electrons (AW Sept. 9, p. 111).

Earth's atmosphere has been extensively explored by signal reflection techniques through the F region of the ionosphere (about 200 mi.), but very little is known about the regions above

this height. Measurement of the rates at which Sputniks I and II were slowed by friction, however, indicate a higher atmospheric density than was expected at these heights.

Ionization Density

At altitudes between approximately 60 and 200 mi., X-ray and ultraviolet radiations from the Sun ionize (break into positive and negative particles) layers of the atmosphere. Ionization density increases during sunlight and decreases at night.

Because as the Earth rotates the number of ionized (charged) particles varies at any one point and because of the influence of the Earth's magnetic field, large electric currents are generated in the ionized region that flow at right angles to the Earth's magnetic lines of force.

One such current circles the Earth at the geomagnetic equator while two others circle the north and south magnetic poles. Magnetic effects observed on Earth during so-called magnetic storms may originate in these rivers of electric current.

The equatorial electric current, under the influence of peak solar intensity at the local noon, is believed to narrow down into an extremely thin (horizontally), high current density stream, termed the "electro-jet." This highly active belt of electric current is believed to be only about 120 mi. wide.

Not only does the electron density of the ionosphere vary diurnally, increasing in sunlight and decreasing at night, but experiments conducted near the geographical poles where the day or night is six months long show diurnal variations that are believed to be associated with geomagnetic activity. Study of these results may change our concepts of the ionizing and recombination process in the atmosphere.

Solar Activity

Because the IGY has been scheduled for a period of maximum solar activity, many of the effects of solar activity on Earth's upper atmosphere and magnetic field can be studied in greater detail than has been possible in the past.

Particles radiated by the Sun reach the Earth at all times, but during the eruption of solar flares along the rim of violent magnetic storms on the Sun's surface this bombardment of the upper atmosphere increases markedly with a wide range of effects.

One effect is the fading or "blackout" of radio signals. Apparently it is the result of greatly increased ionization in the D, or lowest, layer of the ionosphere. The increased electron density causes much greater absorption of electromagnetic energy which is dissipated rapidly through collisions.

During these periods a new layer of ionization is created about 12 mi. below the lower limit of the D layer. It is related to the increased X-ray emission from the Sun during flares.

Particles ejected by solar flares also are responsible for auroral and magnetic storms. Simultaneous radar observations indicate that auroras occur in both the northern and southern hemispheres simultaneously, something long suspected by scientists but not positively established.

Auroral displays appear to result from the deflection of solar particles by the Earth's magnetic field toward one of the magnetic poles. As the particles enter the atmosphere, a complex series of collision reactions produce ultraviolet radiation. This radiation excites different components of the atmosphere as a function of frequency, causing them to emit their characteristic light.

Two theories exist as to how these ionized particles are ejected during solar magnetic storms. One states that these ions are ejected in streams directly away from the Sun's surface, so that these streams are turned through space as the Sun rotates on its axis. The other suggests that ions are ejected as clouds or bursts by the storms at varying intervals. Shock of the impact of these particles on the Earth's magnetic field causes magnetic disturbances here in either case.

Radio Waves Amplified

An interesting effect of these particles striking the upper atmosphere is that they are believed to transfer energy to very low frequency radio waves found there and amplify them in the same manner as in a traveling wave tube. Velocity of these particles (about 1,800 mi./sec.) is only slightly faster than the group velocity of these radio waves; therefore, the particles could be imagined as pulling the radio waves along with them. This hypothesis would account for a previously unexplained type of very low frequency radio noise.

Magnetic field of the Earth extends into space indefinitely. A mode of propagation whereby a radio signal appears to follow these lines of force from one hemisphere to a conjugate area in the opposite hemisphere has been identified only recently.

Very low-frequency radio noises generated by lightning strokes that utilize this mode are called whistlers because of the descending whistle they produce in a radio receiver. Although the propagation paths extend thousands of miles into space, whistler signals have been recorded that were reflected back and forth over 21 times, traveling a total distance of more than 600,000 mi., with little loss of power.

One of the most interesting aspects of whistler propagation is that the signals are believed to travel outward to maximum distance with little loss of energy and to be amplified during return by the traveling wave effect described above. Estimates of electron density along the path (200-300 electrons per cc.) appear to substantiate the theory, based on group velocity.

Cosmic Rays

The upper atmosphere is bombarded by two different types of particles: low energy ions radiated by the Sun that take from 24-40 hr. to reach Earth, and relatively high energy particles, consisting largely of atomic nuclei, that reach the atmosphere with energies between 10^8 and 10^{20} electron volts.

These high energy particles are called cosmic rays. Their existence has been known for 50 years but their origin and nature remain to be found. They arrive from all directions, although at rare intervals the Sun radiates cosmic rays of lower scale energy.

Low energy cosmic rays are deflected towards the two geomagnetic poles by the Earth's magnetic field, and only the higher energy particles penetrate to the surface at the middle latitudes. The line where the cosmic ray intensity is minimum is called the "cosmic ray equator."

The cosmic ray equator has been found to deviate substantially from the geomagnetic equator. Measurements have shown that this deviation is between 30-40 deg., inclined to the west of the geomagnetic equator. This warping is believed to indicate that the rotation of the Earth's magnetic field as it turns on its axis in space, which is a stationary conducting medium, sets up interacting magnetic fields that alter the trajectories of the incoming cosmic ray particles.

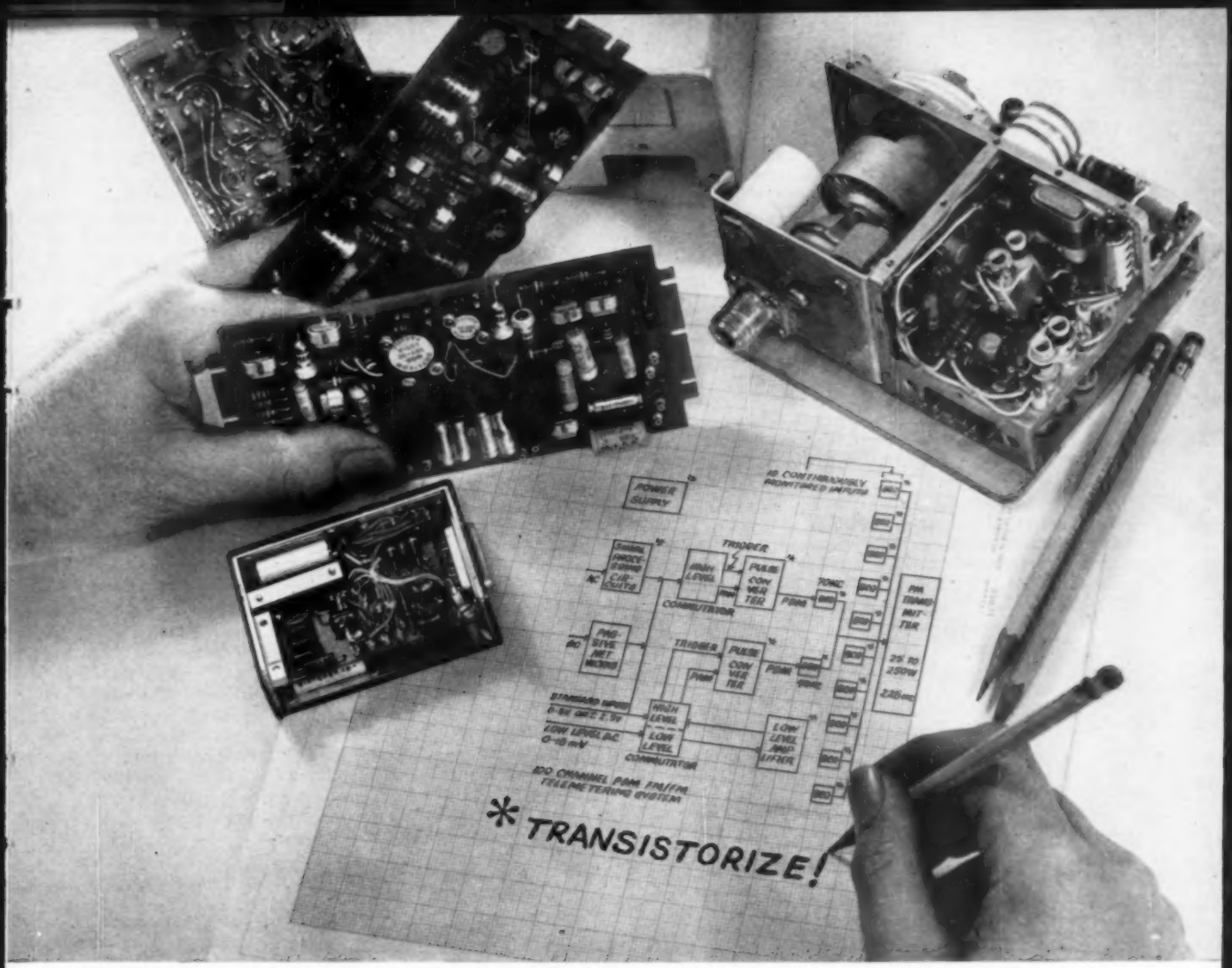
Bright Radar Display Is Visible in Daylight

Civil Aeronautics Administration and U.S. Navy have placed orders for a French-developed bright display system for radar data that will enable air traffic controllers to work in well-lighted rooms rather than in semi-darkness.

System converts conventional radar information into a television signal for display on a standard television receiver. Radar video mapping also can be displayed or, with the addition of a television camera trained on the controller's work table, aircraft identification and airways layout can be superimposed on the radar picture (AW March 25 p. 34).

Contracts have been given to Intercontinental Electronics Corp., Mineola, N.Y. The company is 50% French owned and 50% U.S., with most of the U.S. share belonging to Airborne Instruments Laboratory.

Contract awarded by the CAA after



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Your requirements in telemetering systems or components can normally be met by existing TI equipment, but your most unique developmental problems are equally welcome. And fast, flexible production facilities will deliver *on time*.

*TI Pulse Duration Modulation telemetering equipment shown, clockwise from lower left: Sub-Carrier Oscillator; Phase Discriminator; Low-Level Amplifier; Keyer; Single-Package 200-W Transmitter.

WRITE TODAY for more information on TI telemetering equipments.

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a 10-month evaluation is for 13 TI-440 scan converter units for a total price of $535,500. The TI-440 equipment is composed of the radar-to-television signal converter only, does not include either TV monitor or TV camera for data superimposition.

CAA plans to install the units at Air Route Traffic Control centers and airport traffic control towers where long range sets are in use. Under present plans, all but two of the installations will utilize the video mapping unit of the radar, displaying combined data on 20 in. horizontal monitors.

Other two installations will be for evaluating the technique of superimposing on the radar display a picture of the controller's work table which shows layout of airways and aircraft identification markers.

Navy contract is for the installation of two complete units, including scan converter, monitor and camera, in the Radar Air Traffic Control Center (RATCC) of the Oceana, Va., Naval Air Station, where they will undergo operational evaluation. Award for $105,000 includes preparation of technical manuals.

The complete systems have the name SPANRAD, a contraction of Superimposed Panoramic Radar Display. Advantages claimed for SPANRAD are:

• **Target retention.** Controllable video transformation tube allows controller to retain the past track of an aircraft and predict its future position.

• **Bright display.** Display is visible under conditions of high ambient light.

• **Adaptability.** Wide variety of relatively inexpensive studio TV equipment is adaptable for use with the scan conversion equipment.

• **High resolution.** Television display provides higher resolution by eliminating "blooming" of target echoes and sweep trace.

• **Cross telling.** Transformed radar picture can be transmitted from one control center to another by conventional microwave links or coaxial cable.

FILTER CENTER

► **Tall Tom Makes TEAM**—Electronic countermeasures reconnaissance system, called Tall Tom (AN/ALD-3), to detect, record and analyze enemy electromagnetic radiation over wide range of frequencies, will be developed for Air Force by Hoffman Electronics Corp. and seven associate firms under what Hoffman calls its TEAM (Total Engineering and Administration Management) approach. The $11 million development will be directed by management and technical coordinating groups consisting of representatives of the eight companies involved. (First details on the Hoffman approach were reported in May 6, 1957, issue of AVIATION WEEK). Associate sub-system contractors include: Cornell Aeronautical Laboratory, Filtron Co., Lockheed Aircraft Services, Olympic Radio and Television, Radiation Inc., Sanders Associates and Stanford Research Institute.

► **Three-D for Airports**—Airways Modernization Board hopes to obtain a three-dimensional radar from one of the military services to evaluate its usefulness in the terminal area for obtaining badly needed information on aircraft altitude, as well as bearing and range.

► **ECM for B-52**—Sperry Gyroscope has confirmed earlier AVIATION WEEK report that it has been named weapon system manager for development and production of an electronic countermeasures pod for B-52 (AW June 24, p. 39). System will provide "revolutionary form of electronic countermeasures," including both active and passive types, Sperry says. Approximately 45% of program will be subcontracted to outside firms.

► **Count 'Em**—Traveling wave tube recently produced by Radio Corporation of America is the two billionth electron tube produced by company since it began 28 years ago.

► **Miniaturized Tacan**—The joint Navy-USAF program to develop miniaturized, high reliability airborne Tacan set, expected to weigh about 40 lb., will be announced shortly. Contracts may be awarded to two contractors for parallel programs. New Tacan will be identified as AN/ARN-52.

► **Long-lived Transistors**—General Electric reports that some of its transistors have now operated for more than 26,000 hr. with no change of characteristics, the equivalent of eight hours' operation per day for nine years.

► **Signed on Dotted Line**—Major contract awards recently announced by avonic manufacturers include:

• **Collins Radio** has received $724,000 order from Trans World Airlines for new lightweight communication-navigation equipment for TWA's 33 Boeing 707 jetliners. Included are: automatic direction finders, selective calling, VHF, VOR, glide slope and marker beacon receivers and VHF transmitters.

• **Librascope** reports a $17 million contract from Navy for digital computers to be used in shipboard fire control.

• **Servomechanisms, Inc.,** has received a $1 million Air Force contract for Type MG-3 completely transistorized central air data computers.

THREE-AXIS
FLIGHT SIMULATOR

Providing a flight table which can be continuously oriented in space with respect to three mutually-perpendicular reference axes, the CTI Dynamic Flight Simulator can be programmed directly from the output of a computer. Operating smoothly with no gearing, the instrument accepts independent voltage signals in each of the 3 axes and converts these vector analogs into a position corresponding to the defined space vector.

By thus reproducing the conditions of an actual high-performance aircraft or missile in flight, the unit expands the capabilities of any laboratory.

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Expansions, Changes In Avionics Industry

General Electric's Defense Electronics Division has established new Defense Planning and Development Operation (DEPDO), integrating four division components: Defense Evaluation Operation, Washington, D. C. Technical Military Planning Operation, Santa Barbara, Calif., Electronics Laboratory, Syracuse, N. Y., and Flight Test Operation, Schenectady, N. Y. Haywood S. Hansell (Maj. Gen. USAF, Ret.) has been appointed manager of combined operation.

Other recently announced expansions and changes in the avionics field include:

• **Minneapolis-Honeywell** has established new Missile Equipment Division, to be headquartered at Pottstown, Pa., which will produce automatic control systems for ground facilities of "several prominent U. S. missile programs." New division headed by Marshall B. Taft, is expected to employ 150 persons by end of 1958.

• **Hoover Electronics Co.** has moved into new half-million dollar 31,000 sq. ft. plant and office facility at Timonium, Md.

• **Infrared Standards Laboratory,** Riverside, Calif., is new subsidiary of IR Industries, Inc., which will provide facility to government and industry for test and evaluation of infrared devices and for design and production of IR instrumentation. New subsidiary, headed by Arthur J. Cussen, former chief of Naval Ordnance Laboratory Infrared Division, is located at 10555 Magnolia Ave.

• **Atlantic Research Corp.,** Alexandria, Va., will break ground in March for new 55,000 sq. ft., million-dollar facility, expected to be completed by year-end.

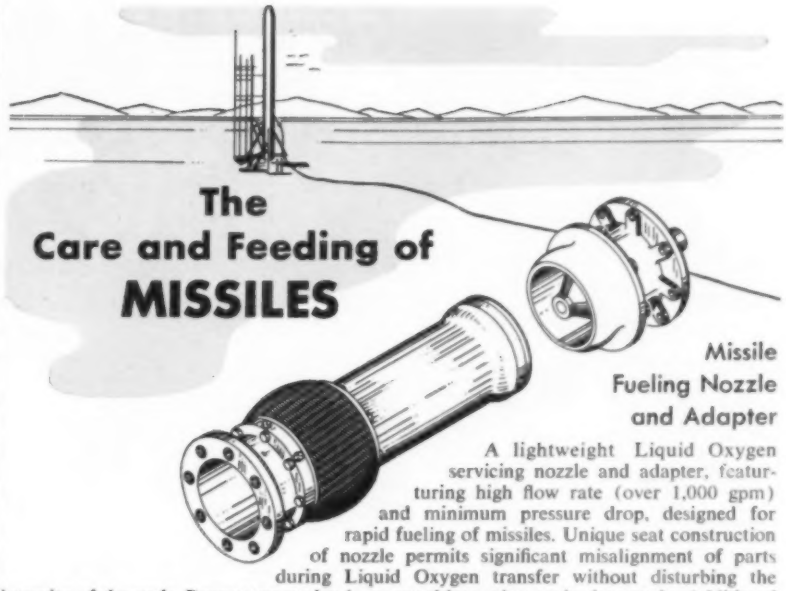
• **U. S. Industries, Inc.,** has opened new 20,000 sq. ft. research and development center in Pompano Beach, Fla.

• **Airborne Accessories Corp.,** Hillside, N. J., has added one-story building to present facilities, company's fifth expansion in 10 years.

• **Autotronics, Inc.,** Florissant, Mo., has more than doubled plant and personnel, raising total facility to 9,600 sq. ft.

• **Hallicrafters Co.,** Chicago, has been purchased by founder, the Halligan family, from Penn-Texas Corp. which purchased company nearly two years ago.

• **Bendix Aviation Corp. Computer Division** has opened new and expanded office in Washington, D. C., at 1000 Conn. Ave. N.W.



The Care and Feeding of MISSILES

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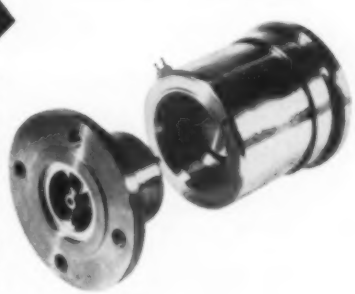
Self-Sealing Nozzle and Adapters for H_2O_2

Designed for servicing aircraft or missiles using Hydrogen Peroxide as an oxidizer, the nozzles feature complete self-sealing. The nozzle must be manually locked before valve can be actuated, and valve must be completely closed before connection can be disengaged. Unit is lightweight and nozzle is protected by a bumper ring to prevent damage. These components are available in sizes from 1½ in. to 6-inches, with flow rates from 50 gpm to 1,500 gpm.

Versatile Quick-Disconnect

Designed to handle wide range of fluids (liquids, gases, and liquid metals), these units are applicable to nuclear power plants and conventional systems. Operation is a simple Push-to-Lock, Pull-to-Open. Both halves are self-sealing, and the unique locking system eliminates need for a separate safety device while providing protection against accidental disconnect during normal operation. QUICK-DISCONNECTS are designed to operate at pressures to 300 psi, and are available in sizes from ½ in. to 6-inches. Provision is incorporated for remote control where such operation is desirable.



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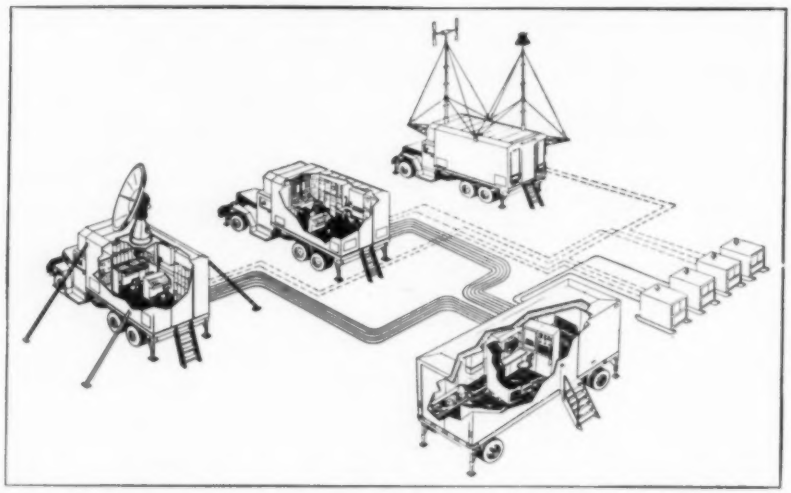
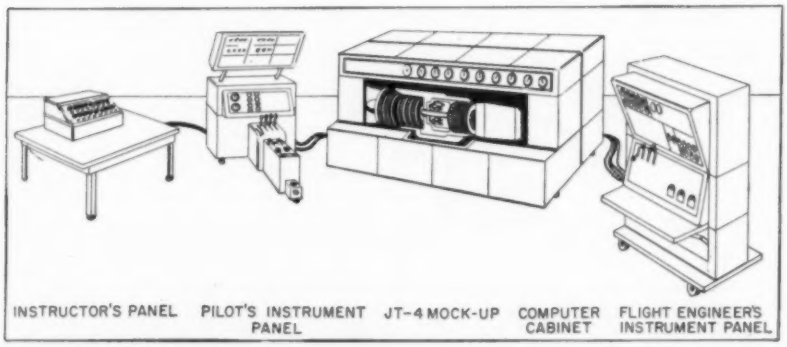
Dayton Representative: *Fred J. Kendell, P. O. Box 622, Far Hills Sta., Dayton, O.*

Link Proposes ICBM Training Program

By George L. Christian



RADAR Signal Simulator (foreground above) simulates TM-61 mission, is used in conjunction with guidance system trailers. Drawing below depicts Link's proposed jet engine trainer.



LINK also is developing lightweight Fiberglas simulator for the commercial DC-8.

Binghamton, N. Y.—Program to develop a comprehensive training weapon system for a sophisticated missile weapon system is under way at Link Aviation, Inc.

Link is proposing to the Martin Co., prime contractor of the Titan intercontinental ballistic missile, a method for setting up an integrated training program which runs the gamut of training devices from simple charts and film and classroom material to human engineering means of merging men and machines and to develop complex electronic missile evaluators.

Present concept of the missile evaluator calls for device to produce within the ICBM almost all the functions—and malfunctions, if desired—of the missile's launching and flight, including guidance, atmospheric effects and synthetic thrust.

Little Weapon

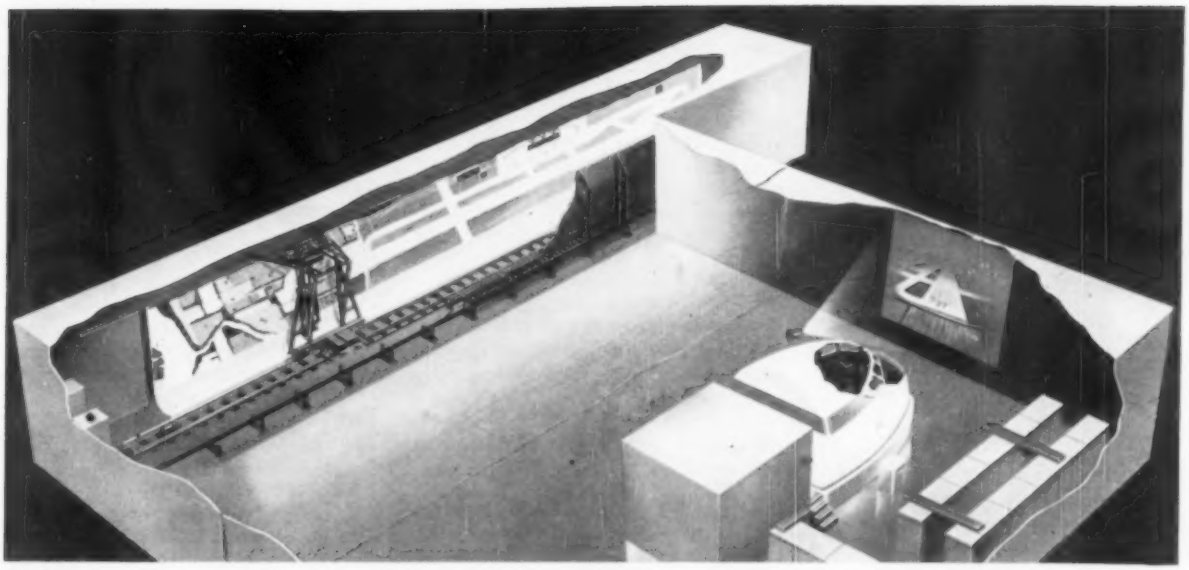
E. Allan Williford, Link president and general manager, told AVIATION WEEK, "Our integrated training system is in effect a little weapon system of its own, simulating all the basic systems and technologies involved in a parent weapon." He said Link system encompasses all the skills and techniques of the entire Titan system—its construction, preparation and use.

Officials point out that their new developments to keep pace with the rapidly expanding missile segment of the aircraft industry parallel, rather than supersede, work the firm has been doing for years in the field of piston and jet aircraft flight simulation.

Link has built nine Radar Signal Simulators (RSS) for Martin TM-61 "A" and "C" type guided missiles. RSS units simulate Matador firing, guidance and dumping in conjunction with MSQ-1A guidance systems.

Link officials said that while the weapon system concept is fine for the prime product—such as an ICBM—the concept should not include training devices for the weapon system. Reason they give for wanting training systems to be bought as separate contracts is that elements of know-how and certain components could be common to many simulators if bought outside the framework of a weapon system. This results in more rapid development of training systems as needed at a lower overall cost, officials contend.

Link's proposal starts with the funda-



CLOSED circuit TV camera (left) scans vertically mounted scale model of airport, projects terrain scene before cockpit simulator.

mentals of missile launching and is fully integrated with the human factors aspects of the program, including Qualitative Personnel Requirements Information (QPRI) covered in Aviation Week July 22, p. 79 and July 29, p. 66.

The program suggests taking an individual with certain basic skills, identifying the area in which he must be trained to become part of an integrated crew, then taking him step-by-step through this learning phase, first as an individual, then as a fully coordinated crew member.

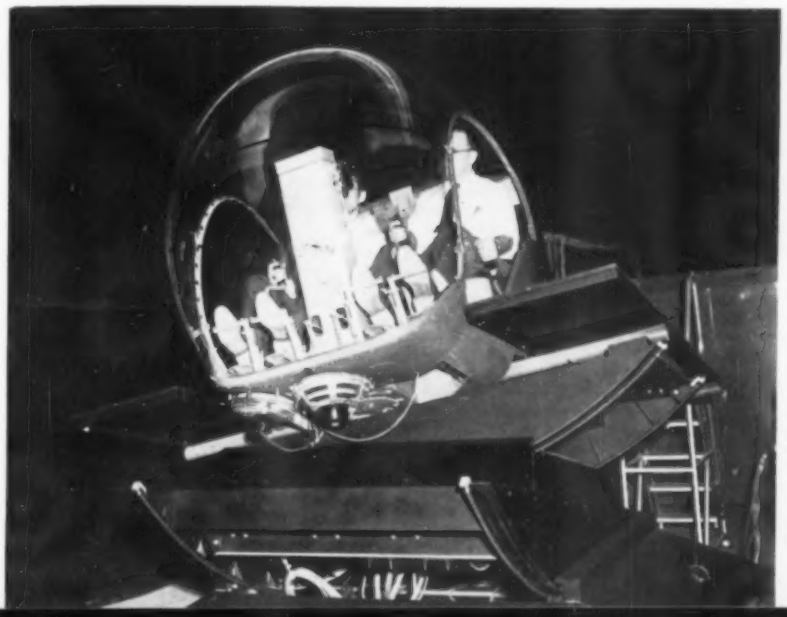
Varied Program

To accomplish this, Link's program goes through these several steps:

- **Helps determine** trainable qualitative personnel requirements for the system.
- **Examines measures** of human performance to be able to specify as early as possible the minimum number of independent measures and the specific characteristics of these measures. These will allow company technicians to estimate the reliability, validity and training effectiveness, or transfer, of the proposed training program and associated equipment.
- **Establishes training** feed-back data which is an essential of any learning situation. Without it, a student's performance either does not improve as a function of practice, or he only improves to a level which he sets for himself as adequate. Since the student's subjective levels of aspiration may not approach the skill levels required for successful operation of a system as complex as the Titan, it is imperative that technicians determine the nature, amount and timing of such feedback.

Link officials said that, having

VIEW of simulated landing approach is shown above. Helicopter flight simulator is below.



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March 5 and 6, 1958

Palo Alto, California

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This Second Annual Shock Tube Symposium offers a great opportunity for pooling of knowledge in shock tube research. A number of short papers will be presented and a trip to the nearby Lockheed Shock Tube Research Facility is planned.

Notice of plans to attend may be sent to:

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New Mexico
Attn: Mr. R. R. Birukoff, SWRS

Those desiring to present short unclassified papers on theoretical and experimental shock tube research should submit abstracts to the above address at the earliest possible date for review. Presentations will be limited to 25 minutes in length. Copies of all papers intended for publication in the proceedings should be available by the date of the Symposium.

The Symposium will be held at Rickey's Studio Inn, conveniently located three miles south of Stanford University in Palo Alto, California. Barrett Transportation, Inc., provides limousine service from San Francisco Airport to Rickey's Inn. Special accommodations for those attending the Symposium are available through Rickey's Inn. There will be no registration fee; the costs arising in connection with participation in the Symposium will be borne by those attending. Individuals should arrange their own accommodations.

reached conclusions in these three basic areas, it becomes possible to examine and select training equipment and develop curricula for its use.

Maintenance of Proficiency

After having acquired individual skills, ICBM crew members must maintain their proficiencies at the highest possible level. This poses a unique psychological problem. A pilot can maintain his flying proficiency by putting in flying time. He can observe first-hand his deficiencies and correct them. To a certain extent, this also is true of missiles guided from the ground. But with ICBMs, all the data is fed into the missile and, once the firing button has been pushed, the missile is on its own. If a crew member makes a mistake, he can do nothing to correct it. After an ICBM has been launched, the only further action the ground crew can perform is to destroy the missile.

Moreover, because of size, cost and political implications, it is impractical to launch many ICBMs for test purposes. It is quite possible that the first time a crew fires a full-trajectory ICBM, it will be because a shooting war is on and not the slightest error can be tolerated.

Use of the Link training system will have several advantages in the psychological field, Link says. Among them are:

- **Count-down and launching** sequence may be repeated frequently to conduct psychological studies of the launching crew in human engineering areas.
- **Intrinsic motivation** is stimulated through feed-back allowing individual crew members to check on their personal proficiency. Instructors also can observe proficiency of each individual or of the team as a whole.
- **Extrinsic motivation,** such as competition between crews, is possible to stimulate pride in team accomplishment. Both types of motivation are essential to maintaining top crew proficiency and assuring the highest possible morale, especially if they are stationed at remote locations, far from their families.

Titan Evaluator

Essential tool in Link's integrated training program is the missile evaluator. As a company official put it, "We will wrap an electronic environment around the ICBM so that, when the button is pushed, everything in the missile will function except the engine. While we will not be able to supply actual Gs, it may be possible to supply synthetic thrust.

"Among cues which we will supply to the missile are signals to the missile's guidance system to see if it will stay on course and environmental conditions which would otherwise have been provided by nature, such as temperature changes, effects of atmosphere—or lack of it—stars for star tracking, if they are required and a host of other electronic cues.

"We aim to develop the best possible way—short of actually firing a missile—of showing the crew what would have happened when the firing button was pushed."

Cockpit System

For the aircraft industry, Link is adding an important new dimension to its simulators—visual simulation outside the cockpit. To date, simulators have provided accurate visual presentation within the cockpit, plus realistic audio cues, but the cockpit windows are glazed over and only lightning flashes are visible to the pilot.

With Link's visual system, a pilot will see on a screen in front of him an accurate, three-dimensional presentation of the approaches to an airport, the actual airfield itself, runway with tire skid marks, hangars, control tower, planes waiting for clearance to take off and all the other sights he would expect to observe during an actual approach. The airport may be an exact replica of the particular field he is being trained for, or it may be a typical airport as seen in the U. S. or abroad.

How It Works

Located remotely from the cockpit simulator, in some convenient spot such as a hangar loft, is a 300:1 scale airport model mounted vertically, representing an area approximately 21,000 ft. long and 3,000 ft. wide; a high optical quality television camera mounted on tracks, and the necessary drive mechanism to synchronize movements of the camera with the pilot's movements of the aircraft's controls in the simulator. Area required is about 15x15x90 ft. System includes:

- **Control system** which is fed basic outputs from the simulator's computer to position the camera correctly, relative to the model of the airport.
- **Projector tied** to the camera through a closed circuit, which shows on a 12x15 ft. screen placed 15 ft. in front of the pilot, view of the plane's approach to the airport.
- **Illumination system** to provide controllable variation in day or night flight conditions. The TV camera is equipped with lights to simulate the illumination provided by landing lights during night landings.

Additional cost of including a visual system with a simulator is approximately $175,000, or about a 15 to 20% increase over the cost of a simulator alone.

Link says that its present visual system, the Mk. IV, was developed for Douglas Aircraft Co. in close liaison

Coast Guard Tests Rescue Basket

Pilot and raft are scooped out of water with rescue basket lowered from Coast Guard helicopter. Basket, developed by Air Force, permits rescue of an unconscious man without lowering crewman into water. Collapsible, the device weighs 38 lb.

with the Television Division of General Precision Laboratory, Inc., Rochester, N. Y., and the Institute of Optics at the University of Rochester.

New Developments

Other than the Visual System, Link has these other new developments for all commercial simulators it is building for the three new jets (Boeing 707, Douglas DC-8, Convair 880) and the Lockheed Electra turboprop.

• **Motion simulation,** other than the long-used rough-air buffeting. Simulators will be capable of duplicating short-term vertical accelerations of up to 1.8G and also roll and pitch effects within certain limits. This advanced type of motion simulation was developed by Link some time ago for its ME-1 basic jet trainer which closely resembles Cessna's twin jet, side-by-side training plane.

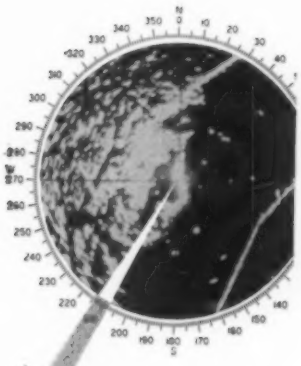
• **Linear interpolators** which are easily-changed printed card circuits. By changing a number of these cards, which are keyed to prevent being placed in the wrong slot, a simulator's "engine" may be changed from one model to another in about 30 min. Prior method required a simulator modification of 10 to 20% to repattern its engine simulation to a plane which had been re-engined for one reason or another. Interpolators also are used in such military simulators as the Convair F-102A, Chance Vought F8U and the Grumman F11F-1.

• **Two-in-one simulator** philosophy. Link engineers are investigating the feasibility of having a certain number of simulator computing systems common to more than one simulator. If the idea proves practical, such airlines as TWA, which is buying Link simulators for the Boeing 707 and Convair 880, may be able to use some computers in common for both simulators.

Simulator Delivery

Link will deliver its first commercial jet airliner simulators to United (DC-8) and Trans World Airlines (Boeing 707) next May, thus establishing a trend by delivering simulators before an airline receives its new aircraft, instead of after. Other airlines scheduled to take delivery of their jet or turboprop simulators this year are: Eastern Air Lines (Electra); KLM (Electra and DC-8); Qantas Empire Airways, Ltd. (707) and SAS Scandinavian Airlines System (DC-8). Link's military simulator contracts include units for USAF's F-106A and F-102A interceptors and Navy F8U and F11F fighters.

Although Link has no contracts for its electronic jet engine trainer, many



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airlines are studying its proposal, according to company officials.

The trainer for Pratt & Whitney Aircraft's JT3C-6 (J57) and JT4 (J75) jet engines is based on DC-8 aircraft installation. Similar jet engine trainer based on the same powerplants as installed in a Boeing 707 also can be provided.

Device allows engine mechanics to study engine starting, operation and malfunction on the ground and in flight, and engine shutdown procedures without the costly and noisy operation of an actual gas turbine engine.

Indoctrination

Some of the advantages of using the jet engine trainer cited by Link include: Thorough jet engine indoctrination for airline mechanics, doubly important because he no longer moves from one reciprocating engine to another which may be more powerful and more complicated than its predecessor, but whose principle of operation is basically the same. Now the mechanic has to learn about an engine whose fundamental operating principle is different from anything he has worked on before. Moreover, commercial engine mechanics will not have the advantage of their military counterparts who started on small and relatively simple jet engines of a decade ago. First jet engines going into commercial service will be large, powerful and complicated powerplants.

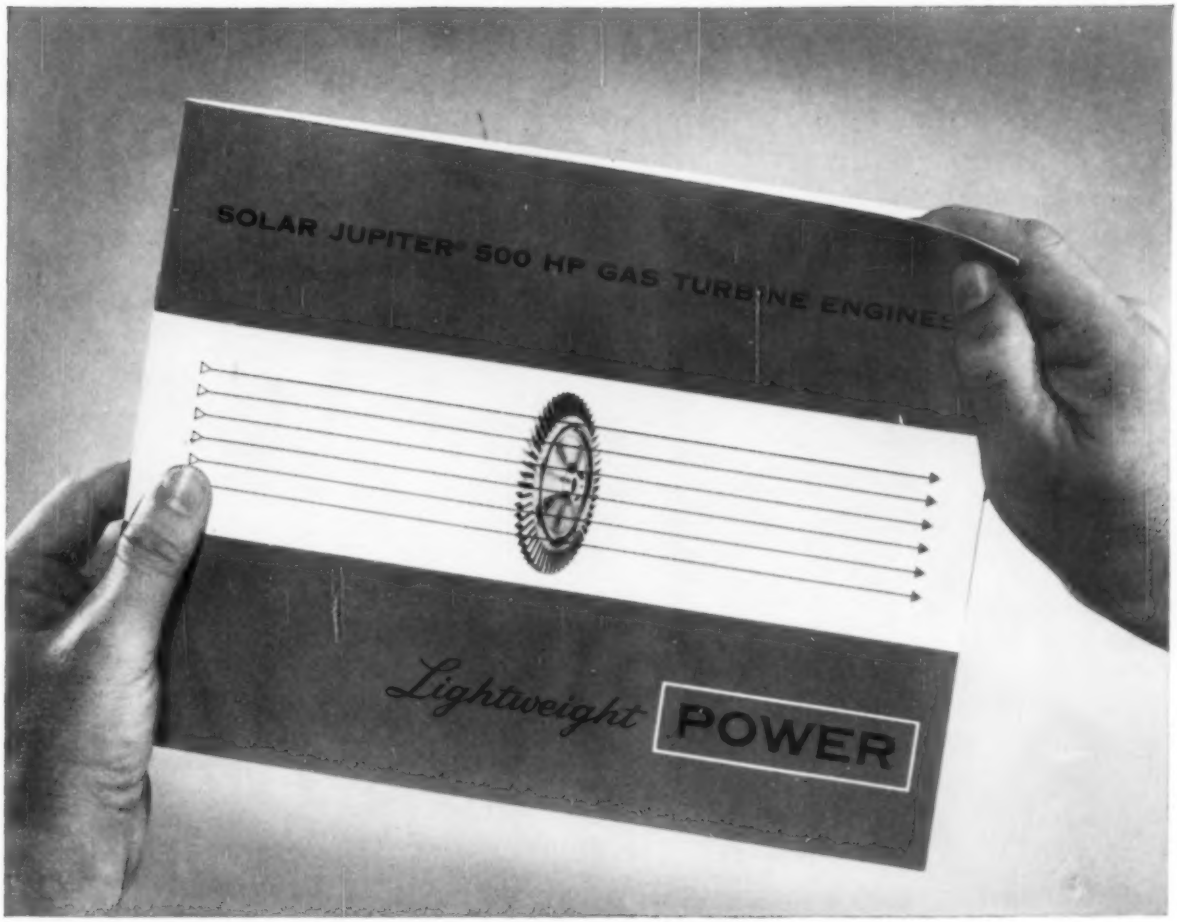
Duplicate Many Conditions

Link officials said another advantage is the ability to set up many engine operating conditions which would be impossible with a live engine because the particular condition would either damage the engine, would be impossible to induce artificially, or would not be possible to duplicate at sea level.

Among these conditions, Link says, are: ignition failure, compressor surge, engine overspeed, bleed valve stuck open or closed, engine icing, flameout and air start and engine seizure.

Other advantages, Link says, are: trainer may be quickly and easily converted from one engine model to another; use of trainer will reduce live jet engine running time for training about 30%; eliminates noise and ingestion problems, and allows ground crews to duplicate conditions written up by a pilot in his flight log.

Link technicians have made a comparative cost study to determine how much money would be saved if a jet engine trainer was used as compared with an identical indoctrination and training course using live jet engines alone. The study used a live jet engine which cost $235,000, with an overhaul cost of $33,000, and embraces 85 ground service mechanics and instructors, 18 maintenance base mechanics



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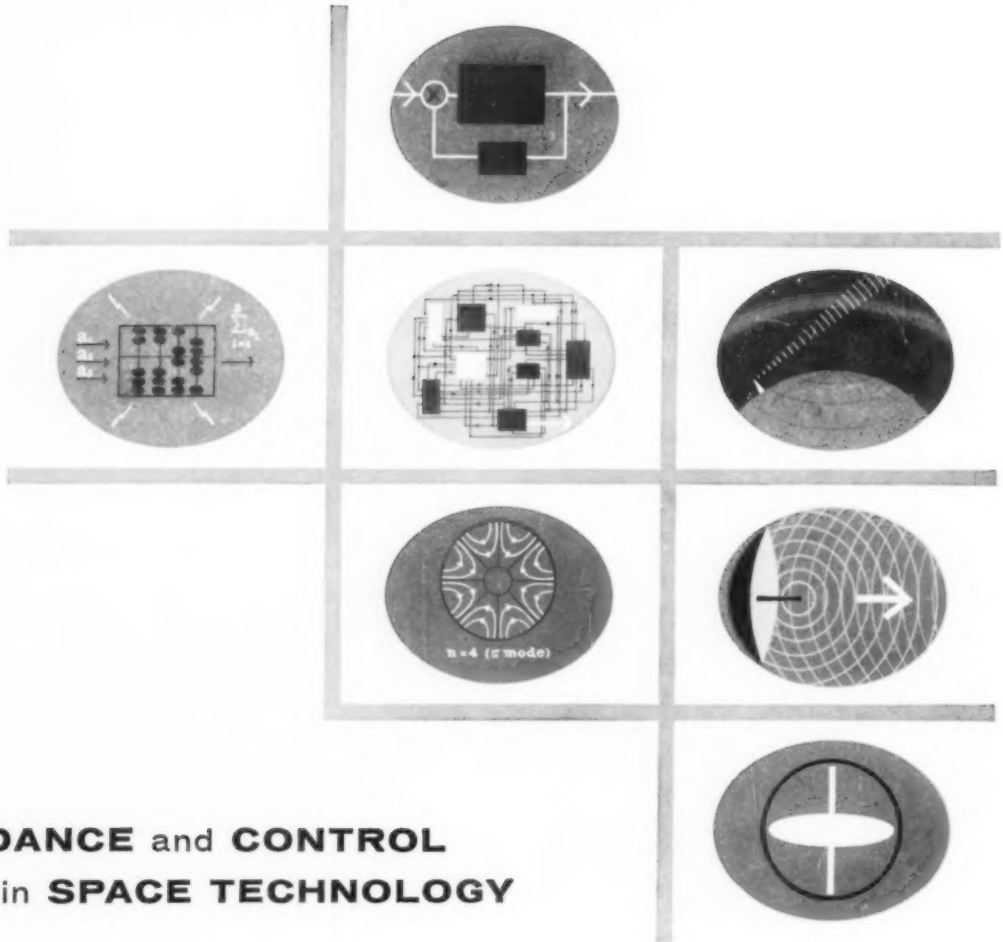

GUIDANCE and CONTROL in SPACE TECHNOLOGY

It is becoming increasingly apparent that many of the techniques and analyses, and much of the equipment, developed for the present Air Force ICBM-IRBM programs will have a wide future application in space technology. For instance, many of the guidance and control techniques for ICBM's are applicable to the space vehicles of the near future.

An important element of these applications is precision. The precision required of the guidance and control system for vehicles aimed at the moon or one of the planets is not substantially greater than that required for the Air Force ICBM-IRBM programs. And, the precision needed to guide a vehicle into a near-circular orbit of Earth is even less than that required for ICBM's.

The problem of communication with lunar and planetary vehicles is, of course, made more difficult by the much greater distances involved. This, however, is not an insurmountable difficulty if today's trends continue in the use of higher transmitted power, narrower communication bandwidths and amplifiers with very low noise-figures.

The problems of operating electronic equipment in the space beyond our atmosphere are already encountered on present ballistic missile trajectories. The principal difference in the case of space vehicle applications is the requirement for longer equipment lifetimes. Electronic equipment and power supplies will have to last for several hours or days or weeks, instead of a few minutes, under conditions of vacuum pressure, zero "g" fields, and bombardment by micrometeorites, high-energy particles, and radiation.

The preceding examples serve to illustrate some of the ways in which the ICBM-IRBM programs are advancing the basic techniques of space technology.

Since 1954, Space Technology Laboratories has been providing over-all systems engineering for these programs. Both in support of this responsibility and in anticipation of future system requirements, the Laboratories are presently engaged in a wide variety of advanced analytical and experimental work directed toward the exploration of new approaches in space vehicle electronics, propulsion, and structures.

The scope of STL's work requires a staff of unusual technical breadth and competence. Engineers and scientists who are interested in advanced experimental development projects (as distinct from development for manufacturing, in which STL is not engaged) are invited to investigate the many opportunities on the Laboratories' Technical Staff.

SPACE TECHNOLOGY LABORATORIES

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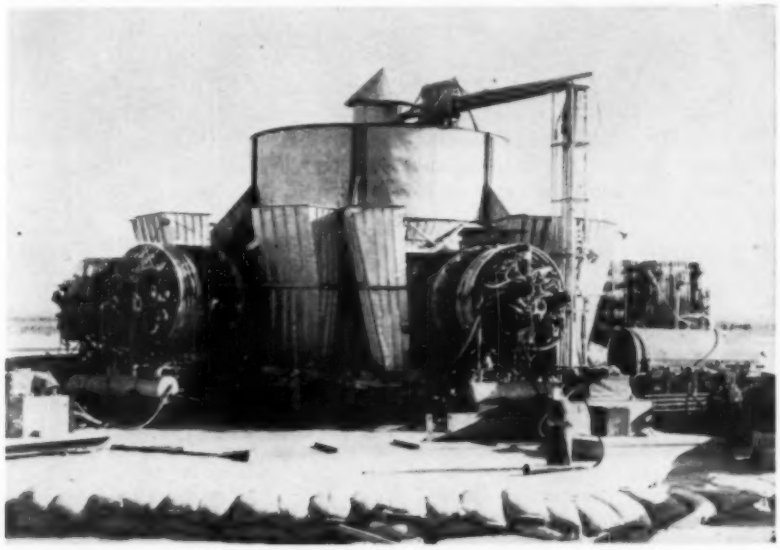
and instructors and 102 flight instructors and officers going through transition training. It also includes additional personnel who would receive annual transition training for 10 years. These are: 17 ground service mechanics and instructors, four maintenance base mechanics and instructors and 20 flight instructors and officers.

The study concludes that use of a jet engine trainer for such a program would save more than $91,000. This figure does not take into consideration loss of revenue that an airline could incur as a result of injury or accident during engine operation or flight training or loss of revenue due to aircraft being assigned to training program.

E. A. Link, chairman of the company's board of directors, created the first Link trainer in 1929. A few years later, Link Aviation, Inc., was founded. In 1954, Link Aviation, Inc., became a subsidiary of General Precision Equipment Corp., which improved the firm's financial position with regard to capital and also made available the services of some 2,500 scientists, engineers and technicians working for GPE's various subsidiaries.



TURBO-CAT aircraft launcher is powered by six Allison J33 turbine engines. Manufacturer, All American Engineering Co., says unit transmits 50,000 hp. to launching cable.

Jet Launcher Proposed to SAC

New York—Strategic Air Command could cut five minutes from scramble time by using a jet-powered aircraft launcher on short dispersal fields, All American Engineering Co. officials said here recently.

All American's "Turbo-Cat" jet launcher and its "water squeeze" cable type arresting gear (AW Sept. 23, p. 86) now is under evaluation by SAC for possible use in airports strong enough for, but too small for, B-52 and B-47 bombers.

Administration's supplemental budget request (AW Jan. 20, p. 28) includes $219 million to expand and speed programs for construction of SAC dispersal and alert facilities.

Charles W. Wendt, All American president, said overall cost of company's Assisted Takeoff and Landing System 600, which includes two "Turbo-Cat" launchers, four arresting gear units and allied equipment, is $2.6 million.

The "Turbo-Cat," Wendt said, can put five B-52 bombers and four KC-135 tankers into the air in less than 15 min. at a dispersal base where the longest runway is 5,000 ft. First aircraft can be off seven minutes after zero, or scramble, time.

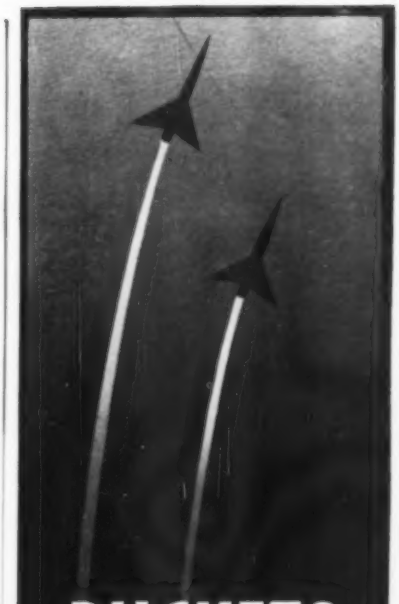
"Turbo-Cat" is powered by six Allison J33-A16A jet engines, transmitting 50,000 hp. to launching cable.

On landing, Wendt continued, the water squeezer arresting gear can stop a bomber 2,000 ft. after touchdown, exerting only a 1½ G force on the crew.

System 600 has not been actually tested with SAC aircraft, company officials said.

Tests run at Georgetown, Del., Sussex County Airport utilized Republic F-84 and McDonnell F2H aircraft, flown by David F. McCallister, chief test pilot.

Safety factors in System 600 arresting gear, outlined by Raymond B. Janney II, chief engineer, "far outweigh" chain system now in use on many military fields. He said chain tends to whip, breaking links and occasionally en-



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tangling aircraft. System 600 utilizes endless belt of cable.

Commercial airlines are "interested" in the assisted takeoff and landing system, according to Wendt, but he said "use of the word 'catapult' has caused some lines to shy, for fear of adverse passenger reaction." He recommends use of a hook on an airline arresting gear system, but admitted "it will hang another 200 lb. on the airframe, and that's a real problem." Wendt backs hook use "because its been proven over the years by the Navy."

RUBBER TIRE BAGS with a liquid capacity of 500 gal. each are pulled in sets of 10 by all-terrain Teracruzer. Fluid bags carry fuel, liquid chemicals or water.

Transporter Tows Fluid Fuel Bags

Ground fluid transporter that tows large rubber tire bags holding 500 gal. of liquid each in sets of 10 or more behind an all-terrain Teracruzer has been developed by the Four Wheel Drive Auto Co. for the Army's Transportation Research and Engineering Command.

Containers for the Four Wheel Drive fluid transporter were developed by Goodyear Tire and Rubber Co. which also designed the pillow tires for the Teracruzer tractor (AW Feb. 4, 1957, p. 96).

Current transporter can carry 5,000 gal. of fuel or other fluid in 10 500-gal.-capacity fluid carriers which are 5 ft. high and 3½ ft. wide.

Over-size tires are mounted in pairs on special axles and towing assemblies equipped with filling, emptying and braking systems developed by Four Wheel Drive.

Actual capacity of the transporter is limited only by the pulling power of the towing vehicle.

Other than fuel, the rubber containers can be used to transport a variety of liquid chemicals, or water for fire fighting, according to Four Wheel Drive.

Filling and Emptying

A system designed by Four Wheel Drive can fill or empty each container at a rate of 50-100 gpm. Units may be filled and emptied by gravity, pressure or vacuum systems. A filtering system is provided for direct pumping of aviation fuels.

Rubber containers resist the effects of a range of chemicals and fuels up to 40% aromatic content, can be stored in temperatures down to −80F and up to 160F and have operating temperature limits of −65F and 125F, the manufacturer said.

Goodyear units are mounted on tubular axles with wheel bearings and hub and rim mountings that allow easy removal and replacement of empty tire bags. They can be equipped with air- or vacuum-over-hydraulic brakes which are operated from the towing vehicle.

Terrain Capabilities

Four Wheel Drive says that by making the fluid containers their own mobile carriers, the transporter can move over terrain such as sand, mud, swampland, boulders, side slopes, hills, ice and deep snow which would bog down conventional fuel-moving vehicles.

Empty containers can be dropped by parachute; full units have been dropped five feet without damage during demonstrations.

Four Wheel Drive has developed other transporters with capacities ranging from 140-1,000 gal. which may be towed singly or in tandem. Goodyear's single containers range in height from 3½-5 ft. and in width from 3½-7 ft. when full loaded.

Lubricant Withstands 600F Temperature

Extreme temperature grease with an operating range from −45F to 600F has been developed by Shell Oil Co. to meet the high temperature demands of supersonic aircraft and missiles.

Labeled grades ETR Grease B and

D, the lubricant extends feasible lubricating temperatures from 500F to 600F. Specifically, its high temperature performance, using ABEC rig, CRCL-35 procedure operated continuously, resulted in a failure time of 104 hr. at 600F.

Shell says that in addition to high temperature range the new ETR class greases are water resistant, have very low evaporation rates and excellent mechanical stability. Company quotes these typical evaluations:

- **Drop point:** above 550F.
- **A.S.T.M. penetration** @ 77F: worked 60 strokes—331; worked 100,000 strokes —384.
- **Torque rate ratio:** (SAE-S-5C method) is lb./sec./-radian at —40F: 2.4.

At 450F bearing performance of the grease will surpass the 500 hr. minimum specified in MIL-G-25013, according to Shell. Company says that the lubricant has been field tested for the past two years.

Payroll Data Process Cuts Cost by $1,500

A saving of over $1,500 monthly in payroll accounting costs is reported by Menasco Manufacturing Co. in processing the payroll of its Ft. Worth, Tex., plant. Costs were reduced, the firm states, by tying in the Texas facility, which employs 350 people in the manufacture of aircraft landing gear and guided missile components, with Menasco's data processing center in Burbank. Utilizing International Business Machines equipment, including a card-punch machine, card-to-tape converters and teletypewriters, payroll data is transmitted daily to Burbank and at the end of the week the accumulated extensions are returned by wire to Ft. Worth in the form of checks. Elimination of manual accounting costs and retention of central control of accounting are chief advantages of system.

Magnesium-Thorium Alloy Reduces Bomarc Weight

Magnesium-thorium alloys are being used by Boeing to reduce airframe weight of the 7,500 lb. Bomarc area defense missile. Selected because of its light weight, stiffness and heat resistance, the material is used in sheet, extruded and cast form.

The missile uses magnesium-thorium alloys in 46% of the upper wing surfaces and 32% of the lower wing surfaces, upper and lower surface elevator skins and doublers, and the entire fin and rudder skins and doublers. Boeing reports that the use of magnesium-thorium alloys obviated a potential supersonic flutter problem due to its high strength-weight ratio.

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USAF Secretaries Defend Budget Reins

Washington—Two top Air Force officials have spoken out in defense of the Administration's policy of keeping defense spending under tight rein.

USAF Secretary James H. Douglas admitted that in the pre-Sputnik area "some of our efforts to determine and control rates of expenditure for procurement were clumsy" and said "there are a few scars," but he said "real benefits came out of this experience."

USAF Assistant Secretary for Materiel Dudley C. Sharp said "monetary restrictions . . . have had at least one great advantage—they tended to give the taxpayer more for his money, with no substantial loss of time."

Douglas said in a recent speech in New York that both USAF and its contractors "were better able to estimate the rate at which procurement contracts were spent" as a result of the spending ceilings.

Their joint efforts to hold down expenditures "resulted in very substantial savings that would not otherwise have been realized," Douglas said. "We are today better able to undertake new high priority projects."

Soviet Russia's intercontinental ballistic missile firings and satellite launchings have raised general concern as to "whether we have spent enough, or are spending enough, on defense," Douglas said, but he believes "the President and the Congress are alert to the danger."

'Not in Immediate Danger'

Douglas' own view is that "we are not in immediate danger today, but that dangers to our national security will increase tomorrow, and day after tomorrow, except as we do those things necessary to maintain an effective deterrent force."

U. S. and its allies together possess enough deterrent strength now, Douglas said. In heavy and medium jet bombers and tankers, the U. S. is ahead, but "in the field of ballistic missiles and particularly satellites, we are somewhat behind the Soviets," Douglas said. "The Soviet missile development, coupled with its large fleet of submarines, constitutes a growing and increasing threat."

Russia's channeling of its most talented youth into engineering and the sciences "is the feature of the Soviet threat that is perhaps the most serious," Douglas said.

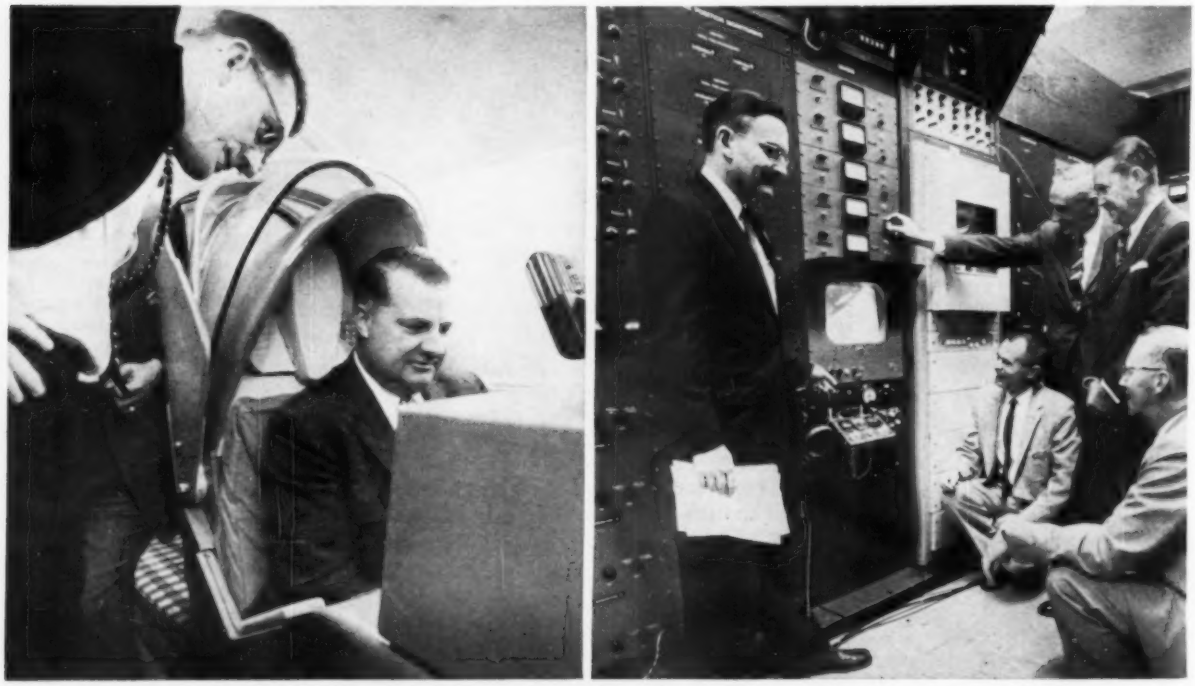
Although the U. S. is strong enough today, the USAF secretary said, "we must be wise in our planning and strong in our effort if we are to maintain our deterrent power in the weapons of tomorrow and of the day after tomorrow."

USAF Steps

Some of the steps Douglas said USAF is taking to keep pace with advances in weapons technology are:

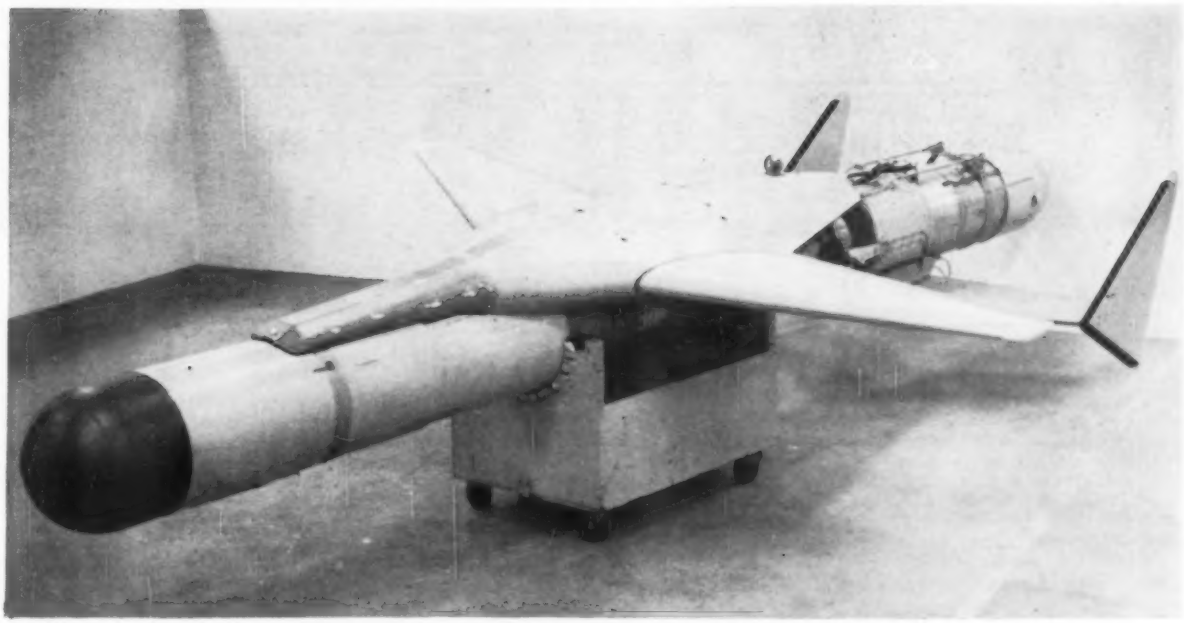
• **"Missiles are not only supplementing** but are replacing manned aircraft." USAF witnesses including Chief of Staff Gen. Thomas D. White and Maj. Gen. Bernard A. Schriever, commander of the Ballistic Missiles Division, testified before the Senate Preparedness Investigating Subcommittee recently that the Fiscal 1959 budget does not provide enough acceleration of intermediate and intercontinental missile programs.

• **"Strategic Air Command** is in the process of being strengthened by the



Lockheed Policy Committee Sees Nuclear Aircraft Cockpit Mockup

C. L. Johnson, Lockheed vice president-engineering and research, examines controls in mockup of nuclear aircraft crew compartment (left) at Lockheed's Georgia Division, Marietta, Ga. At right, Hall Hibbard, Lockheed senior vice president (fourth from left), watches Johnson's reactions on TV. Equipment is in human factors laboratory, used to check factors involved by crew on theoretical five-day flight.



Petrel Powered by J44

Navy Petrel air-to-underwater missile, now out of production, is shown for first time not suspended from aircraft. Anti-submarine missile developed by Fairchild is powered by J44 turbojet. Guidance system is radar homing.

conversion of B-36 wings to B-52s. This process is half completed . . . ." Air Force witnesses, including Gen. Curtis LeMay, former SAC chief and now vice chief of staff, told the subcommittee that production of B-52 and KC-135 jet tankers still is too low. Fiscal 1959 budget includes no funds for increased or accelerated B-52 or KC-135 production.

• **Increasing SAC's alert time.** Testimony by USAF officers indicated they do not think the effort in this direction is yet sufficient, even with the funds provided in supplemental 1958 and Fiscal 1959 budgets.

• **"The first of the supersonic B-58s** are being test flown and are meeting all expectations." Lt. Gen. Clarence S. Irvine, USAF deputy chief of staff, materiel, testified that the B-58 is "a magnificent aircraft" that has been retarded by lack of finances at every stage of its life. First production funds for the B-58 are in the Fiscal 1959 budget.

WS-110A

Douglas also cited work on the WS-110A chemical bomber, overseas deployment of Tactical Air Command—heaviest loser in the cut from 128 planned wings to 117 in the Fiscal 1959 budget; early warning nets and interceptor bases that will include Bomarc missiles; the planned ballistic missile warning system, (AW Jan. 27, p. 26); research with the X-15 rocket aircraft; the WS-132A strategic missile, etc.

Assistant Secretary Sharp, speaking at Ft. Wayne, Ind., attacked the recent "tendency to tear down the public's confidence in our military establishment," including the contentions that "we lack a feeling of urgency, that we allow fiscal limitations rather than defense needs to limit our military effort, that there is excessive waste and duplication of effort among three services, and that our procurement practices are frequently inept."

Sharp Answers Criticisms

Sharp's answers to some of these criticisms:

• **Urgency.** Since "we cannot have all of everything that can be thought up . . . the degree of urgency attributed to each area is a matter of judgment." Sharp cited the ballistic missile program as an example of evaluating proposals carefully "in the light of deterrent strength now and in the future." He said missile work was slowed in 1947 "partially because warheads available then were too heavy," and was revived with top priority "when it was clearly determined that lighter warheads could be made."

• **Fiscal limitations.** The statement that overtime restrictions retarded missile efforts "simply is not so," Sharp commented.

Overtime also was allowed on B-52s and KC-135s when it was necessary to maintain schedules, he said. "It is true that we did not allow B-52 production to reach the higher rate that was once contemplated," Sharp said. "Admittedly, monetary considerations influenced the decision, but it was made primarily to get more model improved aircraft with greater striking power."

USAF "proceeded with somewhat less urgency in its tactical and air defense programs," Sharp said, but "advanced interceptors, fighter bombers and area defense missiles"—including Century Series aircraft and the Bomarc missile—"were pushed at substantial rates."

Development of SAGE "continued in an orderly fashion. It appeared unwise to press forward at a more rapid pace because of many complex technological problems that had to be solved." Sharp said.

Why Aircraft Slippages

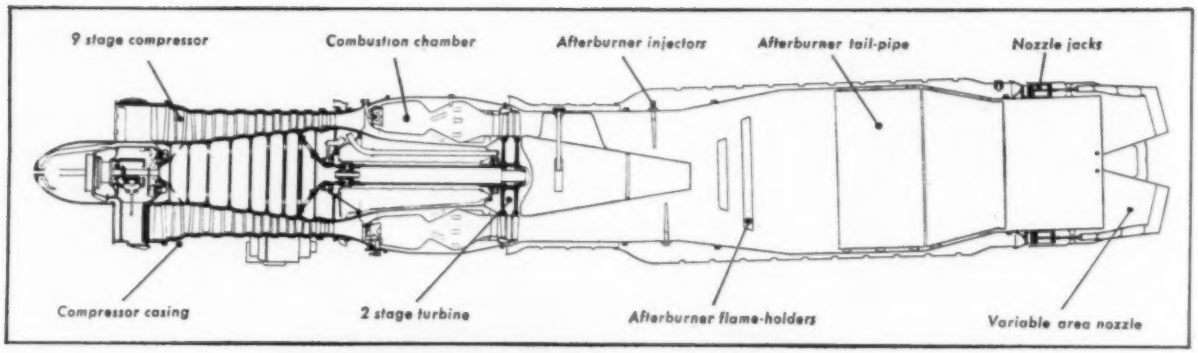
"Some of our aircraft schedules were slipped, largely for technical reasons" on the theory that it is sometimes better to "make haste slowly," he said.

"As a case in point, we could have produced one of our aircraft, the F-106, at a faster rate," Sharp said. "But pro-

Solid Potential

Washington—Development of solid propellants will permit launching of "medium-range ballistic missiles from manned aircraft and should add an important new offensive weapon to our forces," according to USAF Secretary James H. Douglas.

Douglas also says Atlas and Titan intercontinental missile booster engines, "with stages added, can provide propulsion for the launching of relatively large satellites and permit exploration beyond our satellite, the Moon."



Atar 9 Turbojet Utilizes Afterburner

Snecma Atar 9 French turbojet is an afterburner version of the Atar 8. Compressor air intake casing contains six hollow struts which contain the bevel gear shafts, the air starter feeding ducts and the oil vent. Circulating hot air in hub cowling, struts and nozzle guide vanes prevents icing. Combustion chamber is annular, and two-stage turbine is incorporated. Afterburner governor allows throttlability with burner on. Engine is stressed for speeds up to Mach 2.

duction of its fire control system could not keep pace."

Monetary restrictions gave the taxpayer more for the same money and with no loss of time, Sharp said.

"Restrictions resulted in re-evaluation of many of our projects, elimination of some that were outmoded—such as the Navaho—elimination of extravagant practices among some contractors, freeing up of frozen talent, reappraisal of military activities, resulting in elimination of less urgent activities and reduction of overhead.

"Reduction of overtime was involved, but, as I say, it did not adversely affect vital production and development, while it did very substantially reduce costs in many areas.

"In other words, fiscal limitations resulted in a general belt-tightening which now makes more funds available where they are most needed."

Sharp said the sometimes proposed "Single Service of Supply . . . is not the answer" to defense buying policy problems. "In consideration of the size of the services, the Single Supply approach would make systems that are already huge and unwieldy, three times as huge. Continued improved supply coordination is a better solution, even for common items."

Sharp also defended negotiating of contracts as opposed to advertising for bids. He said small business got more than $723 million (8.2%) in prime contracts from the $8.75 billion procurement in Fiscal 1957. Through subcontracts, small business got another $1.5 billion, or 21.5% of the $8-billion paid to 88 large contractors, he said.

"It should be clear," Sharp said, "that the criticism leveled at Air Force buying practices is not fully justified. . . . Why, then, do we have adverse publicity? For one thing the free American practice of criticism is vital in a democracy such as ours. Divergent views are always healthy.

"For another, the press largely, and quite naturally, follows the adage that 'good news is not news.' Critical items are almost always more newsworthy than are favorable ones. We would appreciate a little more emphasis on the brighter side of our picture.

"Then there is the political atmosphere. On this score, I regard congressional hearings extremely useful. They are the people's means of expression and act as the watchdog of the people's interests.

They are an effective means of uncovering deficiencies in the huge and sprawling business of government.

"I believe, however, that they should be temperate, as they largely are. . . ."

Northrop Builds Research Center

Key structure in Northrop Aviation's new scientific research center at Hawthorne, Calif., is this six-story tower. Center is part of the firm's advanced missile and manned aircraft research and development program.

Auto Landing System Uses Reverse Thrust

Air Materiel Command flight test contract for research and development of an airborne flight control system which uses a thrust reverser and permits automatic instrument landings by highspeed aircraft has been awarded to North American Aviation Inc.'s Los Angeles Division. Contract figure is $2,600,998.

North American is system manager of an analytical study and determination of what is required in developing an automatic instrument landing system (AILS) which will take over controls from pilot. North American will not attempt to develop the instruments but will utilize companies in this field. Company's Autonetics Division will develop the flare computer for the system.

Under contract terms, AILS proposes multiple and variable angle glide paths with constant speed control. Contract also includes a requirement for manual operation using component parts of the system and the ability of pilot override of the automatic control. After determination of requirements for AILS, contract provides for design, fabrication and installation in an F-100.

CAB Accident Investigation Report:

Lack of Alertness Cited in Airline Crash

At 0001,[1] Jan. 6, 1957, a Convair 240-0, N 94247, owned and operated by American Airlines, Inc., crashed during an instrument approach to Tulsa Municipal Airport, Tulsa, Okla. The accident resulted in fatal injuries to one of the 10 occupants, serious injuries to six and minor injuries to one. The aircraft was substantially damaged.

HISTORY OF THE FLIGHT

Flight 327 was scheduled between Providence, R. I., and Tulsa, Okla., with intermediate stops including Chicago, Ill., and St. Louis, Springfield and Joplin, Mo. The flight to Chicago was routine; however, the crew, when securing the cockpit, observed that the fire-warning light for the forward cargo and electrical accessory compartments flickered.

This was called to the attention of both the ground crew and the relieving crew (a routine crew change was made) and was written in the aircraft log. Because of necessary repairs to the fire-warning system the flight was delayed 1 hr. 40 min. and it departed Chicago at 1950.

The new crew consisted of Capt. Wesley G. Mims, First Officer Paul H. Johnson and Stewardess Shirley D. Walker. Flight 327 was routine to Joplin and it departed there at 2323 with seven passengers aboard. Leaving Joplin the aircraft weighed 35,940 lb., which was well under the allowable gross takeoff weight; the load was properly distributed.

The flight was cleared by ARTC (Air Route Traffic Control) to the Owasso "H" facility,[2] via airway V-88, to maintain 4,000 ft., and to contact Tulsa approach control on crossing the south course of Chanute low frequency range for further clearance. At approximately 2333, 10 min. after takeoff from Joplin, ARTC, through the company radio, advised the flight to climb to 4,500 ft., to maintain 4,500 ft., and to report leaving 4,000.

This transmission was acknowledged and Flight 327 reported leaving 4,000 ft. at 2334. Approximately 10 min. later company radio at Tulsa gave the flight the Tulsa 2328 weather sequence. The company then gave the flight the local altimeter setting as 30.15 and field pressure as 460 ft. above zero. This was acknowledged and Flight 327 reported it was changing over to Tulsa approach control frequency.

At 2347 the flight reported crossing the south leg of Chanute low frequency range and was immediately cleared by approach control direct to Owasso, to descend to and maintain 3,500 ft., and to report when over Owasso. The 2328 Tulsa weather was given the flight as: Measured ceiling 600 ft., overcast; visibility 2½ mi.; very light drizzle and fog; wind calm.

Later, the flight reported it was 1½ min. from Owasso and asked if any delay was expected. Approach control advised no delay was expected since the only local traffic was then making an ILS (Instrument Landing System) approach.

Shortly thereafter approach control advised Flight 327 that the visibility was then 1¾ mi., that the U. S. Weather Bureau was checking the ceiling, and asked if an Owasso approach straight in to runway 17 was to be made or if an ILS approach was preferred. The flight advised it would make the Owasso approach and at 2357 was cleared accordingly. It was asked to report when over the Owasso facility inbound.

At 2400 Flight 327 reported over Owasso, inbound, and was cleared to land on runway 17L. Two minutes later a special 2355 weather observation was transmitted to the flight as: Measured 200, overcast; visibility 1¾; very light drizzle and fog. This transmission was not acknowledged and nothing further was heard from the flight. Repeated efforts by approach control and other facilities to contact the flight were unsuccessful.

INVESTIGATION

The scene of the accident was on rolling ground 3.6 mi. north of the approach end of runway 17L of the Tulsa Municipal Airport, at an elevation of 613 ft. above sea level. It was determined that the aircraft first struck the top of a tree, breaking branches, and then hit the ground in an almost laterally level attitude 225 ft. farther on, while on a heading of approximately 174 deg. First ground contact was made by the main landing gear and nose wheel. This was apparent by the presence of deep tire marks. A few feet beyond, along the ground path, were marks made by the blades of both propellers. These marks were followed closely by gouges in the ground, which indicated the total collapse of the entire landing gear at this point. The aircraft slid along the ground to the top of an upslope and then jumped a deep and wide ditch, finally coming to rest approximately 540 ft. from the point of initial touchdown.

Fire did not occur.

A search was made back along the flight path for portions of structure which might have broken off and fallen from the aircraft but no such parts were found. Subsequently, all components were accounted for in the main wreckage area.

Both wings were severely damaged. The left wing, although held by cables, etc., was lying flat on the ground and the right wing was folded back along the fuselage. The severed tip of the right wing was found a considerable distance back along the groundpath.

Substantial damage to the fuselage included buckling of the fuselage structure in the cabin area, which caused internal distortion of cabin flooring, seats and overhead racks. Cabin seats were found in varying degrees of failure and collapse. No seat belts were torn or broken. The nose section of the fuselage was crushed inward and the belly was badly damaged.

In the cockpit both pilot seats were torn from their sliding tracks and the left seat was damaged.

The nose gear was torn from its attachment. The main gear broke at its attach fittings and folded rearward. The gear struts appeared undamaged. It was determined that the nose gear and main landing gear were down and locked at impact.

Both engines were found near the main wreckage, detached from the aircraft and damaged by impact forces. Disassembly and examination of these engines revealed nothing that would have affected power output or engine response during flight.

All blades of both propellers were either broken or bent rearward. All parts of the propellers were found and although damaged these revealed no evidence of failure or malfunctioning in flight. Examination of the damaged governors indicated that the left and right engines were turning 2,255 and 2,260 rpm., respectively, at impact. The crew testified that the aircraft and all components were operating in a normal manner throughout the approach.

Instruments Checked

All aircraft navigational instruments were bench checked. Both ADF and omni indicators were found to function within allowed tolerances. The two airspeed and rate-of-climb indicators and the captain's artificial horizon also functioned properly. The first officer's artificial horizon was damaged by impact and was not operable.

Altimeter settings were: Captain's 29.41 (475 above sea level); first officer's 30.12. Both altimeters when tested functioned within normal tolerances below 6,000 ft. No evidence of internal failure, leaks, dust, foreign material or moisture was found in either instrument. Static lines to the altimeters were damaged and broken, and portions were not found. All recovered portions of these lines were examined; nothing was found which could have affected adversely the functioning of the instruments.

All radio units were tested in accordance with standard procedures and found to operate in a normal manner.

The ground navigational facilities serving Tulsa were flight checked subsequent

[1] All times herein are central standard and based on the 24-hr. clock; all distances are in nautical miles.

[2] A nondirectional radio beacon (homing), power less than 50 watts.

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to the accident and found to be satisfactory.

On the morning of Jan. 6 a cold air mass which consisted of a ridge of high pressure covered the eastern portion of the United States and extended to the southwest from the St. Lawrence River Valley into Mississippi and Alabama. Southern Missouri and northeastern Oklahoma were on the western side of the high pressure ridge within the northward return flow of the air mass. The modification of this air mass during its return flow resulted in a cool, moist layer of air, extending from the ground to an approximate height of 4,500 ft. msl., over northeastern Oklahoma, with fog and drizzle at Tulsa.

The U. S. Weather Bureau forecast for northeastern Oklahoma, for the period 1900 Jan. 5 to 0700 Jan. 6, indicated overcast conditions with a ceiling of 2,500 ft. and a top of 5,500 ft. It also indicated that the ceiling would lower after midnight to 1,000 to 1,500 ft. and that visibility would be three to six miles in fog.

The terminal forecast for Tulsa for the period 2300 to 0300 of the same dates indicated: Ceiling 800 ft., overcast; visibility 4 mi.; with fog and occasional light drizzle. The 2355 special weather observation giving the ceiling as 200 ft. was transmitted to the flight by the tower controller at 0002. The crew said it did not receive it.

Prior to the departure of Flight 327 from Chicago, a company meteorologist there briefed the crew on the weather, advising that clouds with ceilings of 500 to 600 ft. and with tops 4,500 to 5,000 ft., together with visibilities of 1½ to 2 mi., could be expected at Tulsa between 1900 and 2100 Jan. 5. The crew was advised further that conditions would lower gradually after that time.

Copilot Flew Approach

Capt. Mims testified that the flight was routine until approaching Tulsa. Throughout the flight from Chicago to Tulsa he and the first officer alternated flying the aircraft, without changing seats, one flying one leg and the other the next, and from Joplin to Tulsa the first officer was at the controls. The captain said that a short time after reaching cruising altitude (4,000 ft.) they went on instruments because of weather and remained on instruments until shortly before striking the tree.

As the aircraft approached Owasso, Tulsa approach control asked what type of instrument approach the flight wished to make. The captain said he decided on an ADF straight-in approach to runway 17, thereby using the back course of the ILS and the Owasso facility as reference for proper alignment.

Accordingly, having been cleared, the flight crossed the Owasso facility initially at 3,500 ft. msl. and began the usual 2-min. standard holding pattern while awaiting approach clearance. Both captain and first officer said they had their ADF approach plates in readiness. While flying outbound on a heading of 354 deg. for 1½ min. the flight was cleared to land. Capt. Mims said he told the first officer that he could descend to 700 ft., but he did not remember telling him 700 ft. on the field level altimeter. (The company's landing minimums for a straight-in approach to runway 17L for Convair aircraft are 400 ft. and 1 mi.) The captain said he then told the first officer to establish a rate of descent of 1,000 fpm. Thirty seconds later a descending standard right turn to a heading of 174 deg. was begun, the landing gear was lowered and the flaps were extended 21 deg.

The captain stated that with the checklist completed they crossed the facility at an altitude of approximately 1,200-1,300 ft., according to his altimeter. The distance from the facility to the approach end of runway 17L is 5.6 mi.

In American Airlines aircraft both captain and first officer have an altimeter in front of them on the instrument panel. According to American Airlines' procedure, when a landing is to be made the captain's altimeter is set to field level pressure so that it would read in actual feet above the airport and zero when on the ground. The first officer's altimeter is set to mean sea level barometric pressure and thus would read, in this instance, 674 ft., the elevation of the field, when on the ground.

Power Applied Too Late

Throughout the approach the captain performed the duties of first officer, with the first officer executing the approach from the right seat. The captain said he did remember looking at his altimeter from time to time during final descent and that he last observed it when it read 700 ft. He fully expected they would be visually contact at 600 ft. He said the rate of descent remained about 1,000 fpm, throughout the entire descent with the airspeed between 120 and 130 kt. He turned on the landing lights during the final portion of the descent but the reflection from the cloud was so great he immediately turned them off. He next remembered glancing out his window and seeing lights to his left. Suddenly realizing he should check the descent, he started to apply additional power but as he did he "felt something grab the airplane or hit it." He immediately pulled all power off.

The first officer testified that he did not remember anything after the start of the approach except that at one point during the descent he noted a reading of 1,500 ft. on his altimeter.

All survivors left the aircraft through the rear service door, the emergency exits and the left pilot's window.

Captain Mims had flown the Chicago-Tulsa route for 1½ years and had approximately 4,000 hr. in Convair aircraft. First Officer Johnson had about 900 hr. in Convair aircraft. The Chicago-Tulsa route was new to him and this was his first actual instrument approach to Tulsa. This flight was also the first time these pilots had flown together.

ANALYSIS

As indicated previously, the possibility of a failure or malfunctioning of one or both altimeters were thoroughly explored during the investigation. However, the fact that these altimeters, when bench tested,

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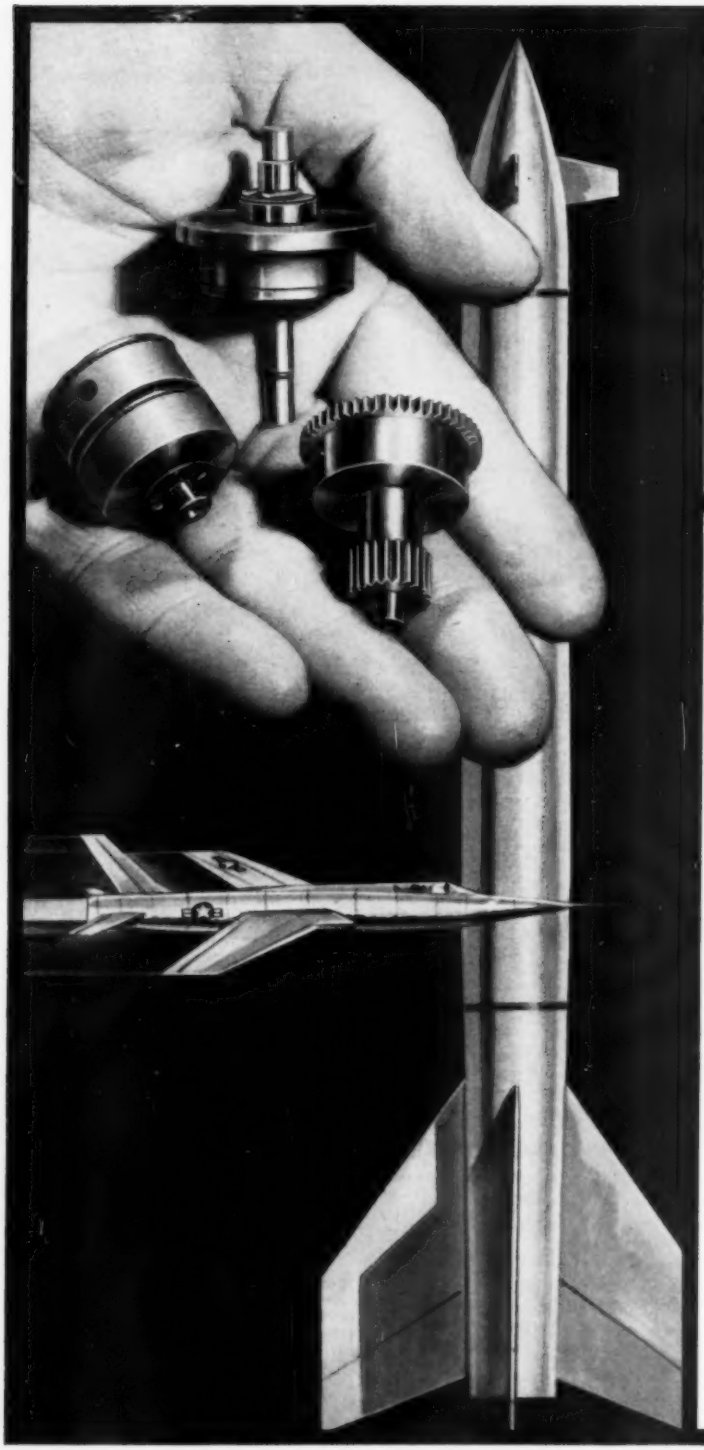

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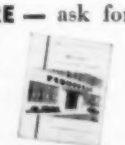

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operated correctly at altitudes below 6,000 ft., coupled with the evaluation of the significance of the altimeter settings found after impact, indicates clearly that these instruments could not have of themselves produced erroneous readings which could have contributed to this accident.

The probability of an error in altitude being introduced by accumulation of water in the static system was also considered. In this connection, it must be realized that the static system is common to both the airspeed and rate-of-climb instruments, as well as to the altimeters. Any effect on the altimeter would be accompanied by a similar effect on the airspeed indicator. Furthermore, the captain's and first officer's pressure instruments are served by separate and independent static systems.

No Instrument Malfunction

It was established that it would be necessary to have a considerable amount of water accumulation in the static system to produce an error in altitude indication of a magnitude necessary to have caused this accident. Moreover, this relatively large quantity of water would have caused airspeed indications much higher than actual. It is possible that the pilot would not have properly diagnosed these errors during the approach; however, he should have been alerted to the fact that something was wrong. Since he testified that the airspeed indications were normal throughout the approach and descent, it is apparent that an altimeter error of any sizable magnitude could not have been present. In any event, because of the duplication of static systems, it is extremely unlikely that an error in one system would occur at the same time and with the same magnitude in the other system. According to American Airlines, the static system drain manifolds are drained at each periodic check, scheduled at periods not greater than 125 hr. The static drain manifolds on this aircraft were drained seven days prior to the accident. A review of the service history of American Airlines' Convair 240 aircraft indicates no unusual operational characteristics of their static system. These records also reflect that this static system compares favorably with the static systems of other aircraft in the carrier's fleet. The Board therefore concludes that altimeter malfunctions of such a magnitude arising from water in the static systems are remote and improbable and that this possibility can be eliminated.

It is worthy to note that this was the first trip Capt. Mims and First Officer Johnson had flown together and that it was also First Officer Johnson's first instrument approach into Tulsa. This is not meant to imply that First Officer Johnson was a novice in instrument flying but rather that his degree of proficiency was unknown to Capt. Mims and therefore, this approach, being made under rapidly deteriorating weather conditions, should have been monitored with the utmost care.

Another factor that must be carefully considered is the weather and what possible effect it may have had on the captain's judgment. The company meteorologist at Chicago briefed the crew of Flight 327, prior to departure, on the probable en route and terminal weather conditions and

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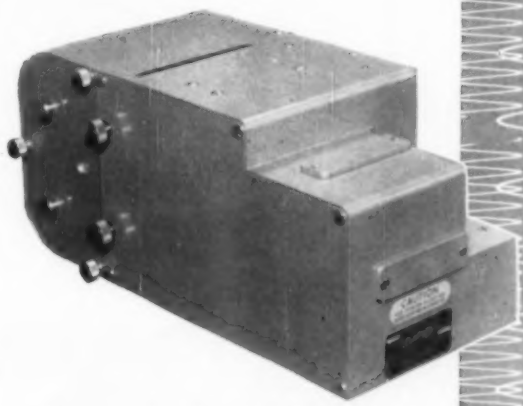

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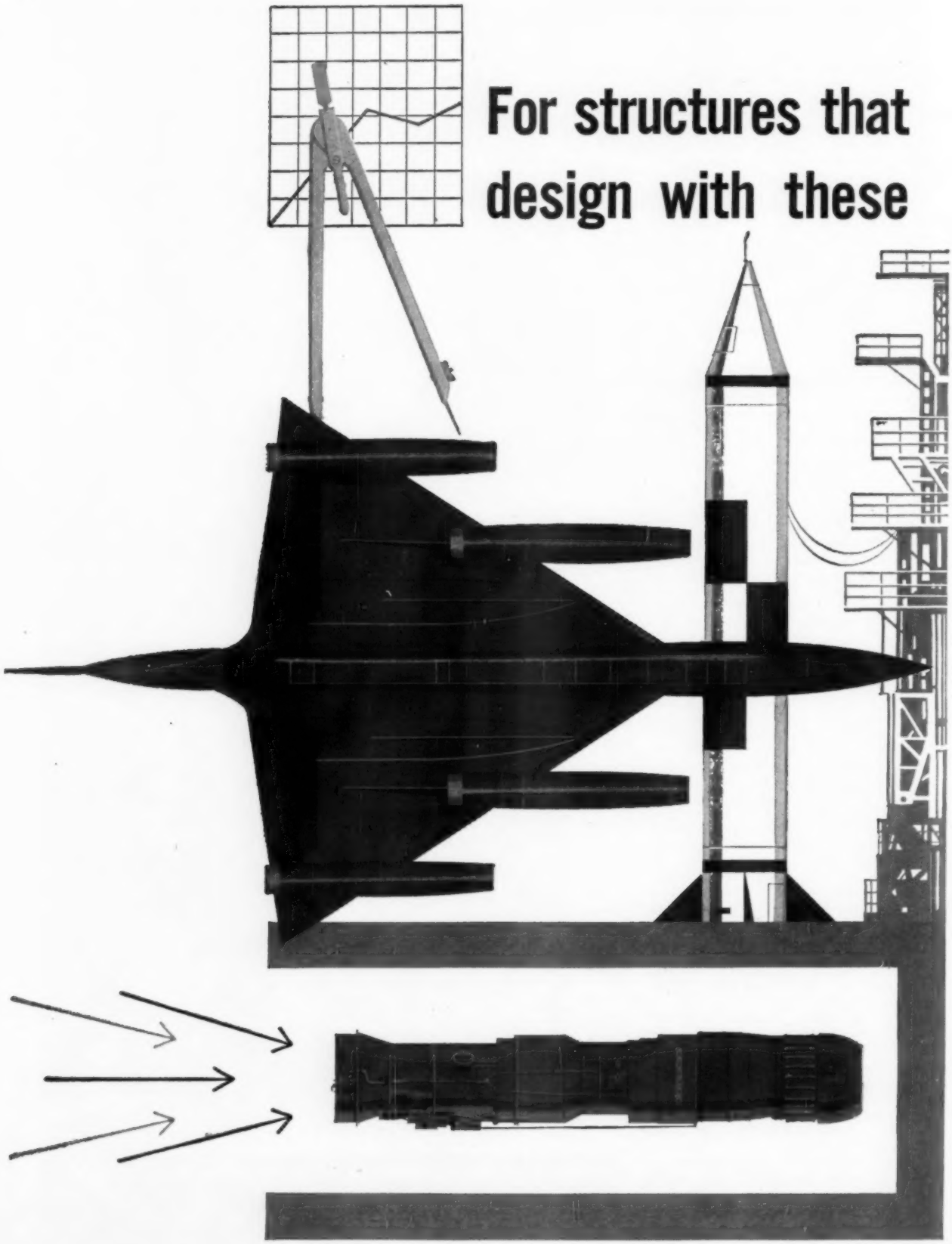

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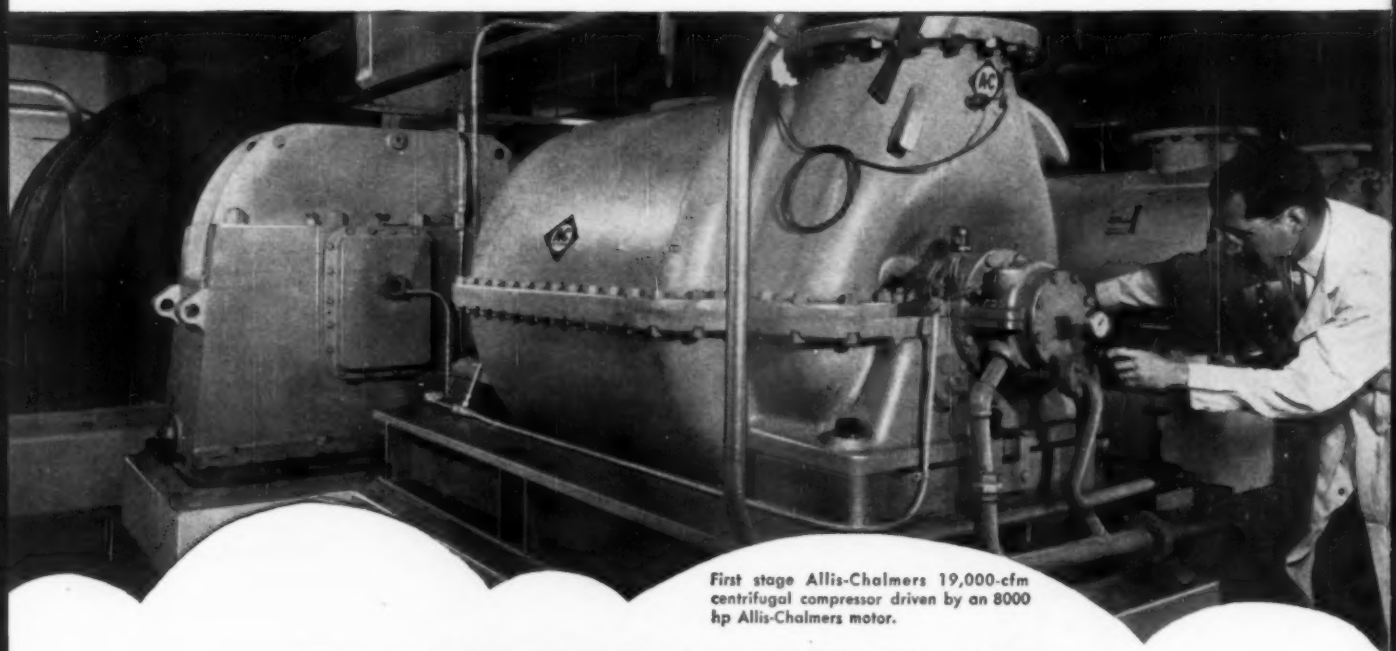

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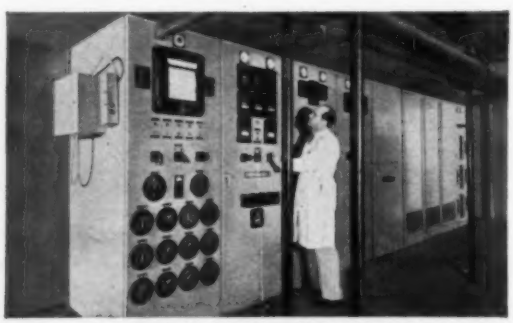

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the expected deterioration of the weather at Tulsa after 2100. When the flight reported crossing the south leg of the Chanute low frequency range, Tulsa approach control gave the 2328 Tulsa weather as: Measured ceiling 600 ft., overcast; visibility 2½ mi.; very light drizzle and fog; wind calm. A short time later the flight was advised that the visibility was then 1¾ mi. and that the U. S. Weather Bureau was checking the ceiling. Notwithstanding the fact that the visibility was lowering and that he did not have the latest ceiling check, Capt. Mims continued the approach, apparently assuming that the last ceiling report of 600 ft. would hold.

Whether the captain, because of this last ceiling report, had a feeling of false security is not known. It is true, however, that with his knowledge that the visibility had actually lowered three-fourths of a mile in a few minutes, coupled with his knowledge of the company terminal forecast, he should have expected the ceiling then to be less than that previously reported. This is of primary importance since it was obligatory that the captain not permit the aircraft to descend below the approved minimum altitude.

Altimeter Policy

As has been stated, it is American Airlines' policy to set the captain's altimeter to field pressure and the first officer's to mean sea level pressure prior to an approach. Capt. Mims testified that the altimeters were cross checked twice prior to the approach to Tulsa and that the readings were found to have the correct relationship to each other.

Capt. Mims further testified that the descent to Tulsa began at an altitude of 3,500 ft. and that he told the first officer he could descend to an altitude of 700 ft. In giving these instructions to the first officer he made no reference to which altimeter should be used. Since the first officer's altimeter was set to mean sea level, a descent to a reading of 700 ft. on his altimeter would have placed the aircraft at or near ground level.

The descent from an altitude of 3,500 ft. was begun at 2357 and the accident occurred at 0001; therefore, approximately 4 min. elapsed from the start of the descent to striking the ground. Since the elevation of the terrain at the scene of the accident was 613 ft. msl., the aircraft descended 2,887 ft. at an average rate of 721 fpm. This is slightly lower than the constant rate of descent of 1,000 fpm. which the captain, in his testimony, said occurred. However, considering such variables as initial lag in establishing the descent and the decrease in rate of descent when a last-minute attempt was made to slow the aircraft down, it is probable that when observed the captain's rate-of-climb indicator did register as he stated.

This average rate of descent strongly suggests that the captain observed a reading of 1,200-1,300 ft. on the first officer's altimeter instead of his own when crossing the facility inbound. This is a logical assumption since at that time the first officer's altimeter should have registered 1,200-1,300 ft. and that of the captain approximately 700 ft.; it is further supported by the fact that the accident occurred about one min. after the facility was crossed. The thought that the reading was made on his own altimeter may have led Capt. Mims to believe he had some 800-900 ft. to descend before reaching his minimum altitude, and thus may have prompted him to permit the descent to continue without realizing the close proximity of the ground. Also, the first officer, in interpreting the captain's instructions to descend to 700 ft., may have planned the approach so as to descend over the station to a 700-foot indication on his own altimeter. Clearly, there was misunderstanding and lack of alertness on the part of both the captain and first officer throughout the entire approach.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The carrier, the aircraft and the crew were properly certificated.
2. The weight of the aircraft was under the maximum allowable and the load was properly distributed.
3. The flight from Joplin to Tulsa was under instrument flying conditions.
4. This flight was the first time the captain and first officer had flown together.
5. The first officer flew the aircraft from Joplin and during the instrument approach.
6. The aircraft and its components, including altimeters, functioned in a normal manner throughout the flight and approach.
7. The last weather report received by the flight indicated weather conditions were rapidly deteriorating.
8. The captain told the first officer he could descend to 700 ft., without specifying mean sea level or above the elevation of the airport.
9. The captain allowed the aircraft to be flown below the company's approved landing minimums for this type approach and to an altitude precluding terrain clearance.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was the captain's lack of alertness in allowing the first officer to continue an instrument descent to an altitude too low to permit terrain clearance.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of the accident at approximately 0130, Jan. 6, 1957. An investigation was immediately begun in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. A public hearing was held Feb. 27-28, 1957, in Tulsa, Okla.

American Airlines, Inc., is a Delaware corporation, and maintains its principal office in New York, N. Y. The company possesses a certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration, which authorize the carriage of persons, property and mail over

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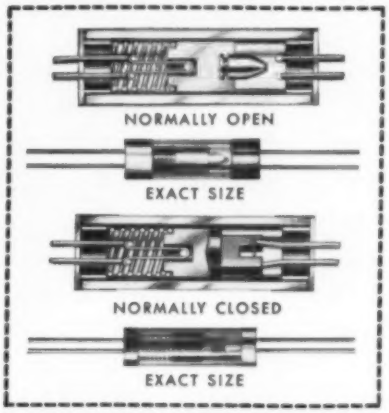

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the route described in this report.

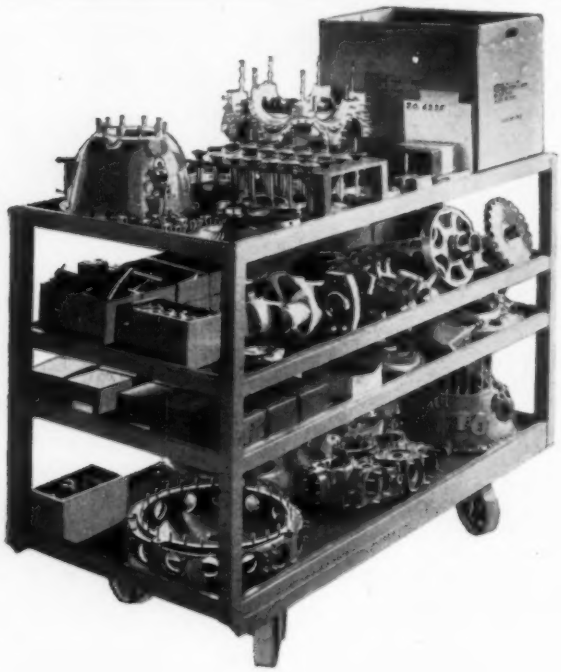
Capt. Wesley G. Mims, age 35, was employed by the company on Mar. 8, 1943. He held a currently effective airman certificate with ratings of airline transport pilot, single- and multi-engine land, Convair and DC-6/6B. He had 8,655 flying hr., with approximately 4,100 hr. in Convair aircraft. His last CAA first-class physical examination was passed Oct. 24, 1956, without waivers.

First Officer Paul H. Johnson, age 34, was employed by the company on June 24, 1946. He held a currently effective airman certificate with ratings of commercial pilot, instrument and single- and multi-engine land. He had a total of 2,170 flying hr., of which 924 were in Convair aircraft. His last instrument check was taken on Oct. 15, 1956, and his last line check was taken on Jan. 2, 1957. He passed his last first-class CAA physical examination on June 29, 1956, without waivers.

Shirley D. Walker, age 23, was employed by the company on May 12, 1955.

The Aircraft

N 94247, a Convair model 240-0, serial number 104, owned by American Airlines, Inc., was manufactured Oct. 7, 1948. Total flight time on the airframe was 18,062 hr. It was equipped with two Pratt and Whitney R2800-83AM4A engines and Hamilton Standard model 43E60 propellers. Both engine time and propeller time were within CAA approved limits.



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PanAm Crash Cause Still Is Undetermined

San Francisco—Civil Aeronautics Board hearing on crash of a Pan American clipper in the Pacific Nov. 8 failed to uncover any facts that would explain why the plane went down and why the crew was not able, before the crash, to send a distress message on one of the plane's four radio sets.

Three theories emerged from the hearing:

- **That the turbine** in a turbo supercharger might have disintegrated, hurtling fragments through the craft.
- **That carbon monoxide,** found in the bodies recovered, might provide a clue to the crash.
- **That a loud noise** heard on the plane during a Sept. 19 flight might mean something was wrong with the airplane, a Boeing B-377 Stratocruiser.

A pathologist testified that "elevated values" of carbon monoxide were found in the victims (bodies of 19 of the 44 killed were recovered). Whether that is significant, or whether it is due to decomposition of the bodies, can be answered only after further research, he said.

Wreckage of the plane showed no sign of damage that would substantiate the turbo supercharger theory, it was testified, but it is a theory that might explain the radio failure and the sudden crash. However, Pan American witnesses testified that in the few such failures that have occurred the fragments escaped through the exhaust stack without doing appreciable damage to the plane.

Pan American witnesses said they examined the plane thoroughly after the noise was reported on the Sept. 19 flight and found nothing to indicate it was caused by a mechanical defect.

In the main, the eight-member investigation panel headed by Robert W. Chrisp heard a recital of things that didn't cause the crash. Among them:

- **Weather.** It was good.
- **Sabotage.** The 98 persons who had contact with the plane before takeoff were interviewed, and nothing was found to indicate sabotage.
- **Maintenance irregularity.**
- **Fire.** Examination of the charred wreckage showed it burned after, not before, the crash. Only one exterior piece was recovered—collector ring from an engine—and tests ruled out a fire in that engine.
- **Propeller malfunction.** They were solid, dural type, and experience with these has been good.
- **Fuel vapor explosion.**
- **Foul play.**
- **Cargo.** Two items were suspect: a radioactive material and sodium sulfide

(Advertisement)

REPORT FROM RYAN

Ryan's Diversification Creates Wide Opportunity for Engineers

X-13 Vertijet Adds New Punch to Airpower

Washington—Unveiled in an unprecedented flight at the Pentagon, the Ryan X-13 Vertijet gave military officials a glimpse of the future of airpower. Like a huge bat, the Vertijet unhooked itself from its nose cable, hovered vertically, then whipped over into horizontal flight and roared out of sight.

World's first jet VTOL aircraft, the Vertijet combines the flashing performance of jet power with the mobility of missile launching. It frees supersonic airpower from runways and airports. Without landing gear, flaps, actuators, the X-13 concept means less weight—more performance in speed and climb.

In the words of a top Air Force General, "The Vertijet has provided military planners with a new capability for manned aircraft of the future."

Achieved in close cooperation with the Air Force and Navy, the Vertijet is based upon Ryan's unsurpassed 2¼ million manhours of research, development, and test in VTOL aircraft.

Navy, Army to Use New Ryan Navigator

San Diego—Navy aircraft—piston engine, jets and helicopters will soon be equipped with Ryan lightweight automatic navigators and ground velocity indicators. Lightest, simplest, most reliable, most compact of their type, these systems are self-contained and based on continuous-wave radar.

The navigators provide pilots with required data such as latitude, longitude, ground speed and track, drift angle, wind speed and direction, ground miles covered and course and distance to destination. Ryan is also developing guidance systems for supersonic missiles.

More Orders for Ryan Firebees

San Diego—Nearly $20 million worth of Ryan Firebee jet drone missiles have been ordered by the Air Force and Navy in 1957. In operational use, the Firebee is the nation's most realistic "enemy" target for evaluating the performance of air-to-air and ground-to-air missiles. It possesses the high speed, altitude, maneuverability and extended duration needed to simulate "enemy" intercept problems.

America's number-one jet drone, the Firebee is another example of Ryan's skill in blending aerodynamic, jet propulsion and electronics knowledge to meet a challenging problem... answer a vital military need.

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The replacement of silver brazed steel with Sciaky resistance welded aluminum has made possible a significant weight reduction in Pratt & Whitney Aircraft's J-57 jet engine.

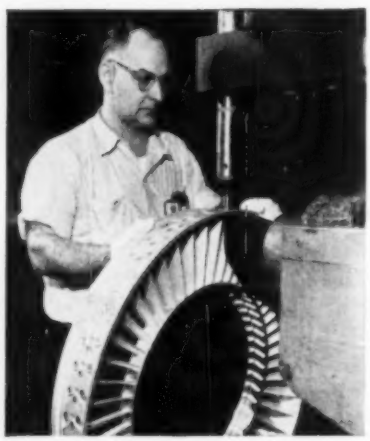
The part affected is the shroud stator of the compressor section. Before the huge Sciaky welders were put into service, the shroud stators were made of steel, fabricated with a silver brazing process.

As a result of Pratt & Whitney's constant research for improvement, project engineers recommended the use of aluminum. Experiments showed that resistance welding, under the 7500-pound pressure delivered by the Sciaky machines, was the only means by which the aluminum pieces could be joined without weldment cracks.

Five Sciaky patented Three-Phase welders producing a total of 740,000 secondary amperes used for this operation represent the largest concentration of such machines in the world. They are described by Pratt & Whitney Aircraft as the only welders capable of satisfactorily welding the aluminum shrouds.

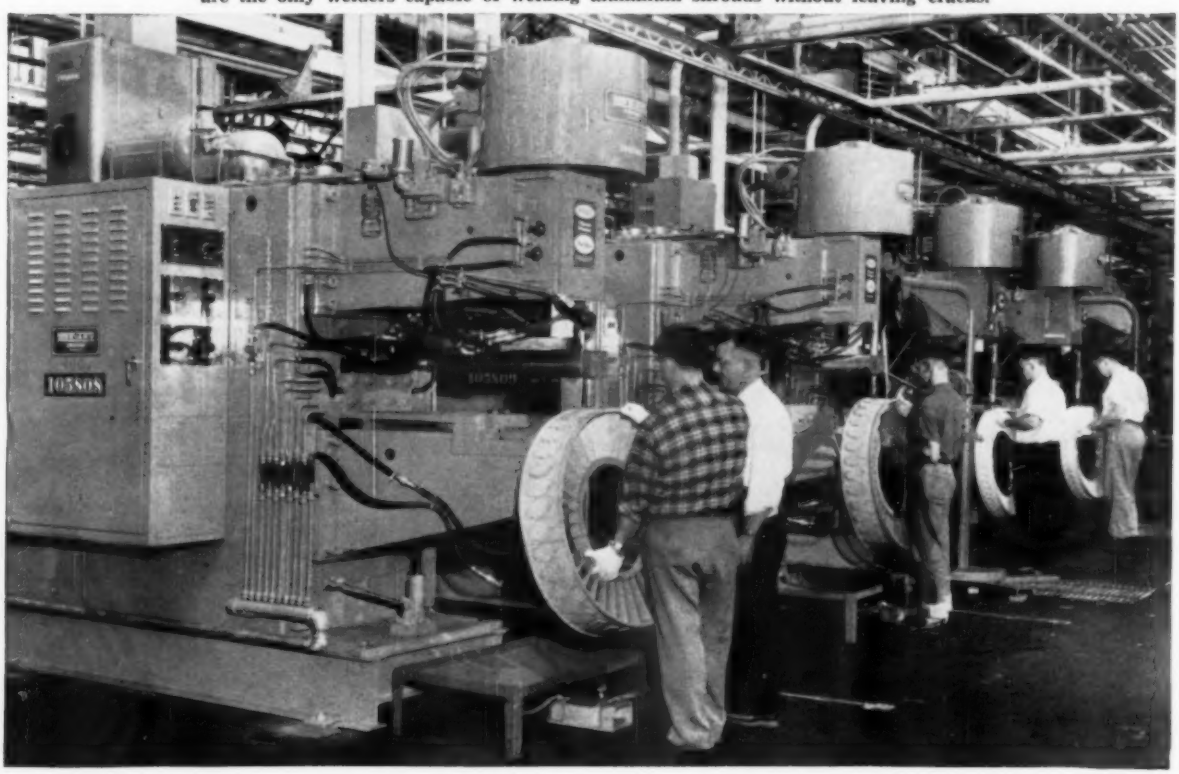
Three of the five welders are equipped with Sciaky Predetermined Electronic Counter Controls. The unique control makes it possible for users to get precisely what they set on the machine. There is no deviation and settings are consistent through the entire range of adjustment. Setup to repeat previous runs is simple.

For further information, write today for Bulletins No. 338 and 339. Sciaky Bros., Inc., 4935 W. 67th St., Chicago 38, Ill., POrtsmouth 7-6500.



Close-up of the shroud stator being resistance welded.

Four Sciaky patented Three-Phase welders installed in the East Hartford plant of Pratt & Whitney Aircraft. Since the photo was taken, a fifth machine has been added. They are the only welders capable of welding aluminum shrouds without leaving cracks.



(dangerous if wet), but the victims showed no sign of being injured by them.

The investigation hearing was held in San Francisco.

TAA Plans to Change Viscount Landing Gear

Melbourne—Trans-Australia Airlines has decided on an extensive program of modifications on its Vickers Viscount fleet to enable the airline to use several secondary airfields as well as to operate more successfully on the long East Coast-West Coast route. The program is expected to be completed in 1958.

Two of the 756 series aircraft will be modified to allow payload to be increased by about 1,200 lb. and passengers carried from 34 to 40 on the long Adelaide-Perth haul. TAA's 12th and 13th Viscounts, due for delivery in mid-1958, will have both landing gear and long-haul modifications incorporated during manufacture.

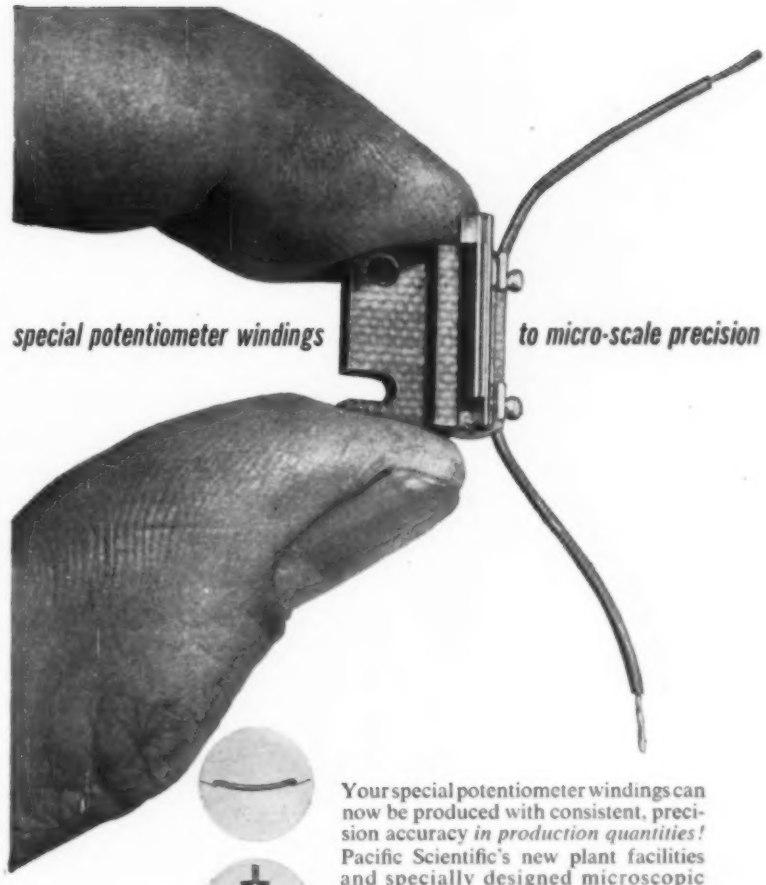
Landing gear modifications have been ordered for the entire Vickers Viscount fleet. The damage which Viscount's high-tire pressures inflicted on runway surfaces was getting TAA into constant trouble with Department of Civil Aviation which progressively restricted Viscount operations to only major airports. The landing gear conversion was ordered despite high costs involved to reduce the tire pressure from 110 to 85 psi. Automatic braking also will be added to Viscounts.

For the long Adelaide-Perth run, where the Viscount found it difficult to compete with DC-6 and DC-6B aircraft, the long-haul modifications will be extensive and will include a general strengthening of structural components. It is understood that at least 3,000 man-hours will have to be devoted to each aircraft. Even then the Viscount will be basically unable to offer satisfactory service on this route and TAA envisages the purchase of Caravelle, Vanguard or Lockheed Electras for this long route.

Six of TAA's 720 Viscounts will be converted to 756 series, giving the older model an extra 25 mph. and an extra 1,000 lb. payload. New interior color combinations have also been ordered.

Fiat to Begin Overhauling Of NATO F-86 Fighters

Fiat Motor Co. will be a repair center for NATO F-86 fighters. About 60 aircraft are involved in the first batch to be turned over to Fiat for overhaul. U.S. designated company and agreed to provide Fiat with several million dollars worth of special equipment necessary for the work.



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French Navy Vertol Releases Bomb Load

French Navy's Squadron 31F at Setif, Algeria, has rigged a bomb rack underneath a Vertol H-21 helicopter for use in combat operations against rebel forces in Algeria (AW Jan. 6, p. 26). Lt. E. Babot, commander of the squadron, installed the rack beneath the forward belly area. He uses the helicopter's auxiliary fuel tank arrangement as a dropping mechanism. Above, the rack carries five bombs. Below, four practice bombs are dropped in salvo. Ten 250 lb. bombs in two rows of five have been mounted and equipped with proximity fuses. The bombs can be dropped individually or in salvo. Bombsight arrangement is in cockpit.

Changes

(Continued from p. 23)

Harold Richardson, assistant manager AiResearch Aviation Service Division, The Garrett Corp., Los Angeles, Calif.

Edgar H. Stelter, service engineering manager, Chicago Aerial Industries, Inc., Melrose Park, Ill. **Willis K. Sutton** succeeds Mr. Stelter as manager of the company's Dayton, Ohio, office.

John F. Chilton, West Coast sales manager, Reed Instrument Bearing Co., Los Angeles, Calif.

Henry M. Wales, commercial products marketing manager, Lear, Inc., Santa Monica, Calif.

Gustaf A. Wallenstrom, consulting engineer-antenna system structures, Technical Products Department, General Electric Co., Syracuse, N. Y.

William B. Wassell, standards engineer, and **W. Marshall Younans**, chief draftsman, Chandler-Evans, division of Pratt & Whitney Co., West Hartford, Conn.

Col. Frank J. Shannon (USAF, ret.), manager-technical field service, Packard-Bell Electronics Corp., Los Angeles, Calif.

W. M. Gillette, manager, Service and Repair Division, Regent Jack Manufacturing Co., Downey, Calif.

Henry J. Hamm, aviation sales manager, Communications Division, Topp Manufacturing Co., Los Angeles, Calif.

Thomas H. Bay, marketing manager, Fairchild Semiconductor Corp., Palo Alto.

John W. Bjorkman, military marketing manager, Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

Charles G. McMullen, director of engineering-government products, Bendix Radio Division, Bendix Aviation Corp., Towson, Md.

Fred Hawkins, public relations manager, Fairchild Engine Division, Fairchild Engine and Airplane Corp., Deer Park, N. Y.

North American Aviation, Inc., Los Angeles, Calif., has appointed two managers of subcontracts and subsystems: **Frank Weixel** for the WS-110 program, and **William May** for the WS-202 program. Also: **Phil Prescott**, purchasing agent.

Murray Kanes, director of engineering, Friez Instrument Division, Bendix Aviation Corp., Baltimore, Md.

Edward F. McDonough, operations control analyst, Electronics Department, Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn.

Ed Trompeter, West Coast factory sales and engineering representative (Canoga Park, Calif.), Nems-Clarke Co., division of Vitro Corporation of America, Silver Spring, Md.

John D. Kohler, assistant manager-aircraft and missiles sales, Flexible Tubing Corp., Guilford, Conn.

Norton C. Sather, manager-West Coast office (Hollywood, Calif.), American Bosch Arma Corp., Hempstead, N. Y.

R. F. Creasey, deputy chief engineer, Aircraft Division, English Electric Co., Ltd., Lancashire, England. Also: **B. O. Heath**, chief project engineer; **E. Loveless**, chief airworthiness engineer; **F. E. Roe**, chief development engineer. **J. C. King**, formerly the Division's assistant chief engineer, has joined the company's Directorate of Engineering in London.

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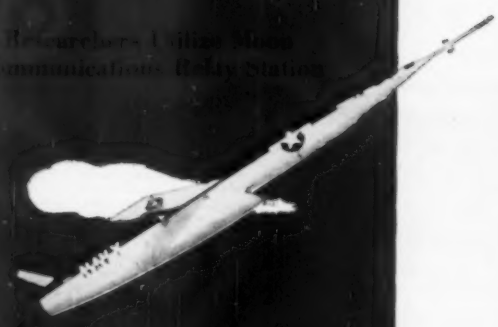

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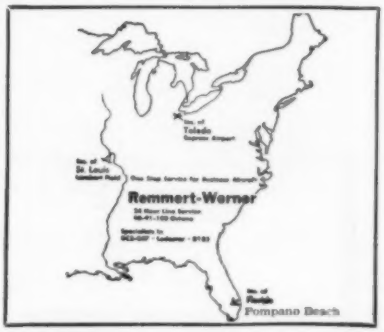

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LETTERS

Freedom or License

Please allow me to offer a vehement second to your indictment by Mr. J. K. Burkely (AW Jan. 6, p. 118).

I am sure that you consider yourself to be a 20th Century Paul Revere, galloping furiously through the political darkness venting frenzied shouts of warning to the complacently slumbering populace that the Red rockets are coming.

That they are coming is true. But they have been coming since 1917. They will not be stopped now by making every detail of our military developments available for public inspection. The irresponsibility of the American press in this matter is appalling. Freedom of the press is a necessity, granted. But where does freedom end and license begin? And who shall be the judge?

The real tragedy of this situation lies in the fact that you and other representatives of news media fail to understand or even see your error. You are literally blind drunk with the power afforded a free press in the United States. In effect, you are arrogantly forcing the American military establishment into the ring with his arms, legs, eyes and ears laden with telemetering devices. He may get the stuffing knocked out of him, but the American people and the world are going to enjoy the luxury of a complete, technical analysis of every drop of blood, sweat and tears shed as he goes down.

J. CALDWELL
Sunnyvale, Calif.

Shrunken Heads

Apparently little regard to historical data of irreplaceable value is considered by the authorities in control of such material at Wright-Patterson Air Force Base. It may come as something of a shock, as it did to me personally and the members of the American Aviation Historical Society, that the negatives from #1 through #44,000 have been destroyed because (1) they constituted a fire hazard, (2) that the quality of the prints from these negatives was considered to be of inferior quality.

By way of explanation, these negatives have been on file since 1918 and no fire has resulted from their storage, and secondly, the quality of the photoprints from the majority of these negatives is sharp and clear.

Naturally, the officials in charge insist that these negatives were not wantonly destroyed and perhaps to their constipated brand of thinking it may not seem so. But to hundreds of serious collectors and aeronautical researchers this hardly sounds like a plausible explanation. This wanton destruction occurred in April, 1957. To save face, the negatives were microfilmed, and accordingly 8x10 blown up enlargements are all that will be available of a valuable segment of aeronautical history covering the period of 1917-1931. Having received some of these blown up 8x10 photos, I personally can testify that they are of poor quality and leave much to be desired to the serious collector.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

However, lest these officials at WADC be entirely to blame, it should be noted that the U.S. National Air Museum, Washington, D. C., and the National Archives also declined to the accession of this historical material. In addition, other civilian agencies who may have the desire to preserve historical material of irreplaceable value are prevented by government edict from doing so. The Air Force Central Museum apparently also presented a disinterested attitude toward the accession of this material. Enlarged prints from microfilm are usually not as satisfactory as prints from the original negatives.

It should also be emphasized that with this kind of attitude toward the preservation of historical data, that any of the intimate details of our air power development can be preserved for future generations only by vigorous action against an entrenched bureaucracy which to them appears to be a routine day to day job.

Here is a good example of the way that the agencies of the Defense Department function. Economy being the watchword, the first effect of this action is to destroy valuable records on the request of the fire chief, limit the already limited funds of the struggling Air Force Central Museum, and justify this action by government edict. Surely not all the heads that are shrunken are to be found in the jungles of Brazil!

WILLIS L. NYE
Hayward, Calif.

Not Democratic

The article entitled "Renegotiators Ordered Industry to Refund $33.6 Million in '57," p. 24 of the Dec. 30 issue, prompts a few remarks on the subject.

I have observed how renegotiation affects both large and small businesses engaged in work for the government. The effect is not healthy, and the process is not democratic. It appears that private business is bound by a contract while the government is not.

Obviously it is not to the advantage of the American people when any private business or industry makes excessive profits while serving our government. On the other hand, if through good management and improved processes savings to both the government and the business are effected, is it reasonable to renegotiate these profits? If so, then the contract is meaningless.

Consider the grocer who must today rehaggle profits from a sale of groceries made two months ago. What would be thought of a law giving his customer the right and opportunity to do this? Were such a renegotiation common practice, could the grocer stay in business? Would he even want to?

Perhaps this estimate of renegotiation is over-simplified. However, I have never read or heard anything which logically supports this process as it is being practiced.

JOSEPH H. ANDREWS
Spokane, Wash.

'Little Horror'

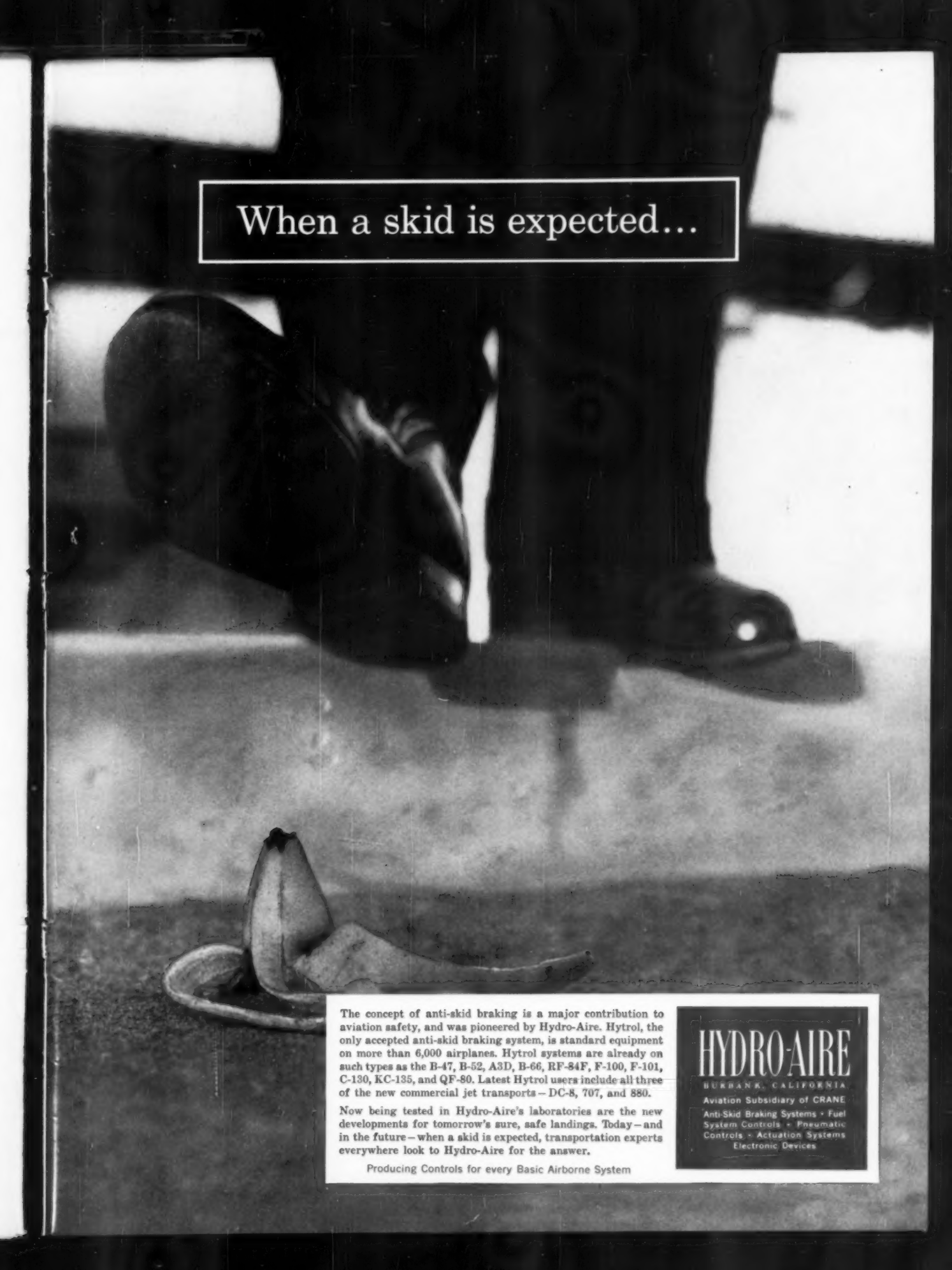
Mr. Doty's article on Chicago's Midway Airport (AW Dec. 16, p. 38) is most timely and describes a situation that is all too well known to air travelers having frequent occasion to make connections or interchanges there. It would be instructive to see figures comparing the number of passengers passing through Midway with those originating or terminating flights there.

On the assumption that these will show a heavy preponderance of through passengers, I suggest that the "trouble with O'Hare" stems almost exclusively from the paucity of flights using that field, and that the relative accessibility of Midway and O'Hare from the Loop is a very secondary factor. The solution to Chicago's air traffic problem would then appear to consist primarily of expediting the move from Midway to O'Hare, rather than completing construction of throughways to O'Hare. At least one airline has initiated a transfer of some flights to O'Hare only to reinstate them at Midway following a period of reduced load factors. As Mr. Doty points out, major airlines are loath to make the move, which will result in a reduction of their load factors during the transition period, until the majority of air carrier operations have been transferred to O'Hare. This reluctance is heightened when the duration of this transition period is a matter of pure conjecture.

It appears probable that this transition could be expedited by the creation of a firm plan for the phase-over of operations from Midway to O'Hare, agreed by the major airlines concerned. Such a plan might be initiated by the airlines themselves, or perhaps by the City of Chicago. This transition must ultimately be made in the not too distant future when jet transports enter scheduled service. It therefore seems highly desirable to simultaneously speed up the availability of superior airport facilities at Chicago, while minimizing the pain of transition among the airlines concerned.

Your publication can do a real service to aviation by continuing to spotlight the situation at Chicago and to press for a speedy resolution of the problem. Truly, Chicago's air traffic movements exert a significant influence on the national air travel picture, and Chicago's delays have coast-to-coast repercussions. It is a sad commentary that this key airport enjoys the sobriquet of "little horror" by the pilots that use it. Let's put the nation's and the world's busiest airport in a position to handle today's air traffic with minimum delays, come IFR or CAVU, without requiring fantastic competence on the part of its air traffic controllers.

D. M. HELLER
South Bend, Ind.



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